VOL. IX, No. 2 APRIL, 1927 Old Series Vol. XXV, No. 2

The Journal of Bone and Joint Surgery

CENTRAL SARCOMA OF BONE.

IS THERE A CENTRAL FIBROMA OR FIBROSARCOMA AND HOW CAN IT BE DIFFERENTIATED FROM OSTEITIS FIBROSA?

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NOTE: This is the third in a series of articles prepared for this *Journal* by Dr. Bloodgood on the general subject, How to Diagnose and Treat a Bone Lesion. *Editor.*

I feel quite confident that the third article of this series should take up this little understood form of bone tumor and try to correct the misinformation in the literature, for part of which I am responsible. In the first paper of this series (July 1926, Volume VIII, No. 3, page 470) I discussed and pictured chiefly central lesions, from an x-ray standpoint, giving no illustrations of gross or microscopic appearances.

Let us for a moment review the illustrations which I selected: Figure 1, a central chondroma of the lower end of the femur with an intact bone shell, with extension up into the shaft, with an ossified line of demarcation between the shadow of the tumor and the marrow shadow. Let us again emphasize that the bone shell is intact, that this x-ray was taken in a routine examination for arthritis. In the first clinic the diagnosis was sarcoma and amputation advised. In the second clinic exploration was made for biopsy, and after finding chondroma the tumor was curetted. This patient is well in 1926 (ten years) with good function. Figure 7 pictures a central chondroma of the shaft of the humerus, also, as that in Figure 1, in an adult about fifty years of age. There had been pain in the arm about four years and swelling three months, while in the chondroma in the lower end of the femur there had been pain in many joints and a limp for seven years. In Figure 7 there is the same ossification in the line of demarcation between the central tumor and the marrow as in Figure 1. But the bone shell in the central enchondroma of the humerus shows ossification. In this case the section removed at biopsy was diagnosed chondrosarcoma and a shoulder-joint amputation was unnecessarily performed. This establishes the fact that benign central chondroma may be present both in the shaft and in the epiphysis. In the series which I have studied these central chondromas came under observation in adult life. Apparently a central chondroma may appear anywhere. The periosteal

chondromas are more common than the central. Their occurrence in the shaft, both central and periosteal, destroys the explanation that they arise in the epiphyseal cartilage. Apparently wherever there is bone formation, there may be cartilage formation.

These chondromas explain the central chondrosarcoma. In my first article, Figure 11 is an x-ray of a central myxosarcoma of the humerus. Here, after local resection, there was recurrence and death from metastasis. Apparently it is also true that wherever one finds chondroma, one may also find the pure myxoma, a very dangerous tumor to deal with, and the myxoma may be associated with chondroma or sarcoma, but the myxoma has a greater local virulence than either, and after the first local recurrence ultimately kills by internal metastasis. The myxoma may also be periosteal. We are all familiar with the bone cyst, chiefly observed as a central lesion of the shaft in young children and adolescents. But in this first paper in Figure 2, I called attention to a latent bone cyst in the epiphysis of the internal condyle of the femur in an adult, and another latent bone cyst with a pathological fracture in the shaft of an adult woman. Therefore, whenever we explore a central tumor in the shaft or epiphysis, we must bear in mind that we may be revealing this very innocent lesion that needs little more than a fracture to cure it, or it must be distinguished from fibrosarcoma, chondroma, myxoma and chondromyxosarcoma. As a matter of fact, it is frequently confused, as will be illustrated later on.

After seventy-five years of continuous discussion in the literature, the giant-cell tumor is now pretty well known. The majority are familiar with its common occurrence in the epiphysis of the adult bone. In spite of its very common occurrence and of all these studies, there are still a few pathologists who cling to the view that there may be a malignant giant-cell tumor. This view of the minority of pathologists apparently still influences a large number of surgeons to be more radical in the treatment of the benign giant-cell tumor than the local conditions justify. The reaction against amputation and resection which has temporarily lead to curetting in an increasing number of cases is now leading to radiation. For this reason it is very important that there be a rediscussion and restatement of the proper attitude towards the benign giant-cell tumor.

In the Journal of Radiology for March 1920, about seven years ago, in reporting one hundred and forty cases of central bone lesions twenty-five were classed as sarcoma, and now we know that a large number of these were not sarcomas and many reported as central were diffuse sarcomas.

CLASSIFICATION OF CENTRAL SARCOMA IN 1920

Myxosarcoma	2 cases
Fibrosarcoma	4 cases
Various forms of cellular sarcoma	11 cases
Malignant bone cysts	8 cases
Total	25 cases

CLASSIFICATION OF CENTRAL SARCOMAS IN 1926

The two cases of myxosarcoma or myxochondrosarcoma remain unchanged. One is pictured in my first article in this *Journal* (Fig. 11) and the other is illustrated in Figure 1 in the 1920 contribution. Of the four fibrosarcomas discussed in 1920, today two are considered certainly benign bone cysts and one is without doubt a spindle-cell sarcoma of the fibrosarcoma type, and one is undoubtedly central, but it is a question whether it is a sarcoma. We therefore have no positive proof of a central sarcoma of bone with an intact bone shell of the fibrosarcoma type. It is a well recognized periosteal tumor. The same tumor occurs in the lower jaw and may be central, but all cases with intact bone shell are border-line tumors between fibroma and fibrosarcoma. The restudy of the eight cases of malignant bone cysts reported in 1920 leaves only two undoubted cases, —both bone aneurysms. One had an intact bone shell; one did not. Both were cavities filled with blood, lined by friable tumor tissue. The sections of this tumor tissue contained no giant cells. So malignant giant-cell tumor may be excluded. Both patients died of internal metastasis. Of the

FIG. 1

Case 1. Pathol. No. 19179. Antero-posterior view. Central osteitis fibrosa of lower epiphysis of femur. Symptom of onset, fracture in woman aged 35. Non-union, exploration, amputation.

FIG. 2

Case 1. Pathol. No. 19179. Lateral view of case shown in Fig. 1. Note in both the intact bone shell and the presence of but very little new bone in the line of fracture, in spite of six weeks since the fracture. Callus most marked in Fig. 1.

The characteristic x-ray is the appearance of the condyle in this picture. This mottling I have observed in bone cysts, giant-cell tumors, and chondromas.

remaining six, two were hemorrhagic cysts lined by giant-cell tumor tissue,—benign tumors; one, a benign bone cyst filled with fluid, and the remainder probably of periosteal origin. A restudy of the eleven cases diagnosed as various forms of cellular sarcoma shows that in not a single case was there an intact bone shell. They were sarcomas of the destructive type and so circumscribed that in spite of the bone destruction they were looked upon as central. Microscopically, the majority were round-cell sarcomas of the Ewing type, or definite angiosarcomas of the endothelial or perithelial variety. None were osteogenic and none presented the histological picture of sclerosing sarcoma.

It will be most helpful to operators and pathologists and to roentgenologists, if it is possible, to make these facts in regard to central bone lesions clear. At this time and from now on, we have a more enlightened public. The majority of our patients report immediately because of pain, swelling, limp, or loss of function, and when the x-ray is taken, central lesions of bone are surrounded by a definite bone shell. There may be a pathological fracture and in a few instances in adults it may be the symptom of onset. It is very helpful, therefore, to know that the most common form of central sarcoma is the myxochondrosarcoma, which should be easily recognized from fibroma or osteitis fibrosa by its fresh appearance in the frozen section. The bone aneurysm is identical in the gross with the hemorrhagic bone cyst within a giant-cell tumor. The fresh frozen section of the friable tissue lining the bone shell should distinguish one from the other. We also have a very practical rule: when in doubt, curette with thermal and chemical cauterization, because up to the present time, in not a single instance has a verified myxochondrosarcoma reached the five-year limit, nor has the bone aneurysm (the malignant hemorrhagic bone cyst).

FIG. 3

Case 1. Pathol. No. 19179. Gross pathology. Longitudinal section of the femur shown in Figs. 1 and 2. Note the cavity which contained clear fluid; the thick zone of tissue lining the bone shell. This tissue had the consistency of leather. This gross picture is typical of the benign bone cyst.

Among the living cases now approaching the five-year limit, there

are two chondrosarcomas, both amputated; one myxoma (amputated)*; and one myxoma (curetted).

I have restudied this group of central lesions at frequent intervals since 1910 when I made my first contribution in the Annals of Surgery (August 1910) on Bone Cysts, Giant-cell Tumors and Bone Aneurysms. But in 1920 in spite of this, misinformation was published in the Journal of Radiology. The correction of these misstatements has been made possible by accumulated experience, by a very much larger group of cases, by the helpful consultations of Codman's Registry Committee, and by the more recent experience with earlier stages in which the bone shell is still intact, except perhaps for a pathological fracture. At the present time I think we are in a very good position to outline a mode of attack when the x-ray shows a central bone lesion whether there be a fracture or not, and I discussed this in the first paper of this series.

FIG. 4

Case 1. Pathol. No. 19179. Low-power photomicrograph of section through leathery connective tissue lining the bone shell in Fig. 3. The spicules of bone are evidence of ossification; they are not part of the bone shell. We would not expect ossified areas in a sarcoma of this type.

*March 1927: Patient has metastasis to brain.

It seems to me that the first group to picture in the x-ray and in the gross and microscopic appearances are the bone cysts found in the shaft and epiphysis of the bones of adults, and the comparatively rare fibroma and possible fibrosarcoma.

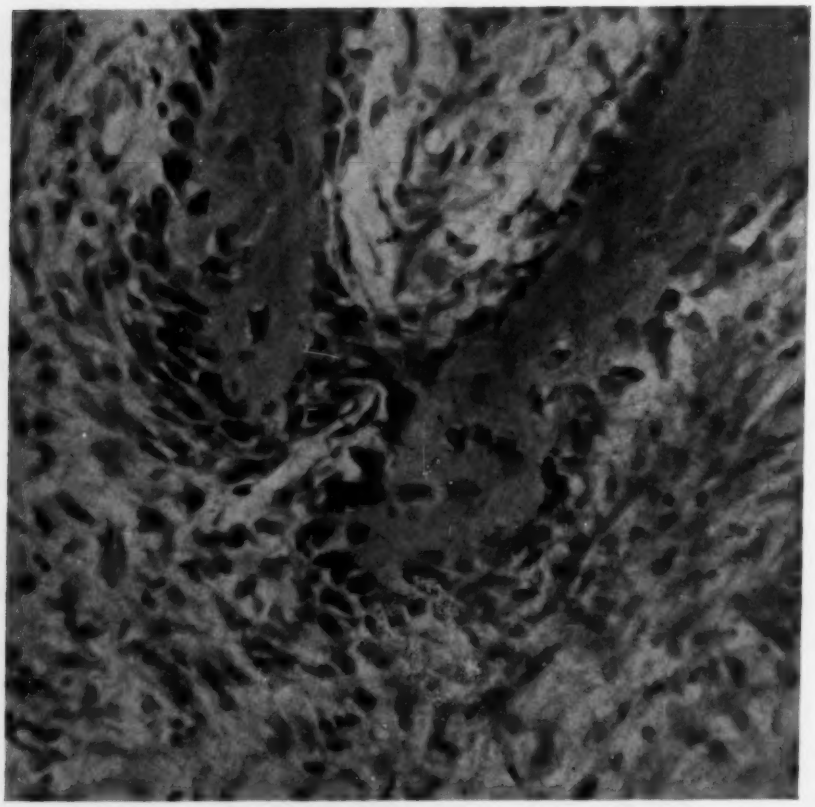

FIG. 5

Case 1. Pathol. No. 19179. High-power photomicrograph of area shown in Fig. 4. This section was diagnosed fibrosarcoma from a piece removed at biopsy, and on this diagnosis the leg was amputated in 1916. The patient is well in 1926. Against sarcoma in this section is the absence of spindle cells in whorls, the presence of cells of many forms,—none typical of sarcoma. In the unhardened, fresh specimen stained with polychrome methylene blue, in this case, I believe sarcoma could have been excluded, because of the absence of typical sarcoma cells. (See second paper of this series, this *Journal*, October 1926.)

EXAMPLE OF A BENIGN BONE CYST IN THE LOWER EPIPHYSIS OF THE FEMUR WITH PATHOLOGICAL FRACTURE. EXPLORATORY INCISION. DIAGNOSIS FIBROSARCOMA. AMPUTATION THROUGH MIDDLE THIRD OF FEMUR

CASE 1. (Pathol. No. 19179, Figs. 1, 2, 3, 4, and 5.) In the first place it is important to record that this patient is well in 1926, ten years after amputation. It is one of the cases briefly reported in the Journal of Radiology for March 1920 (Figs. 23, 24 and 25) under the diagnosis of a central malignant bone cyst. When submitted to the

Registrar, the majority of pathologists agreed that it was a fibrosarcoma. A few were doubtful, inclining to inflammation. At the present time the majority agree with the conclusion that the lesion is osteitis fibrosa.

This case of bone cyst illustrates many exceptions to the rule of this lesion of adolescent bone. It is present in the epiphysis instead of the shaft. It was observed in adult life instead of in youth. In spite of a pathological fracture, after some weeks observation, there was little or no ossification even in the line of fracture and no ossification whatever in the tumor area.

Figures 1 and 2 picture the lateral and anteroposterior views. These x-rays were taken some six weeks after the injury. The surgeon who explored wrote me that he passed through a thin bone shell, a fibrous connective tissue lining and entered a cavity filled with clear fluid. The wound was closed and healed. When I studied the sections microscopically in 1916 I had studied carefully osteitis fibrosa. Nevertheless, I made a diagnosis of fibrosarcoma appearing in the form of a central malignant bone cyst, and when this patient was sent to me the limb was amputated. In

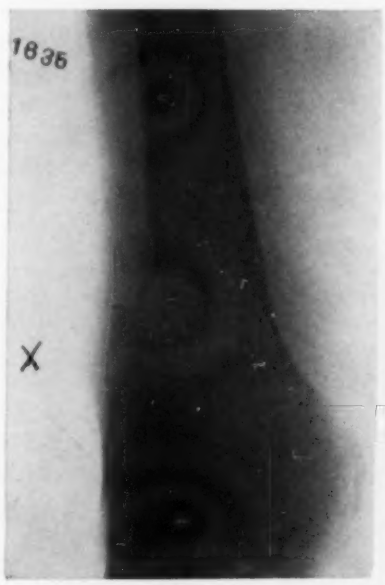

FIG. 6

Case 2. Pathol. No. 26593. Osteogenic sarcoma of the lower shaft of the femur. Note the area of destruction in the shaft outline and line of demarcation unlike a central tumor. Note the periosteal growth to the inner side, through a defect of total cortical destruction. This x-ray is pathognomonic of sarcoma and should lead to amputation without exploratory incision, which was done by Dr. Gale of Roanoke, Virginia.

FIG. 7

Case 2. Pathol. No. 26593. Lateral view. This x-ray more distinctly than Fig. 6 indicates marked cortical destruction which can be more easily explained by a periosteal or diffuse sarcoma than by a central. This patient lived almost three years after amputation. Cause of death at eighty not known.

1916 I was not familiar with the occurrence of bone cysts in the adult and kenw it was very rare in the epiphysis. As years went on and this case was constantly demonstrated to the classes as fibrosarcoma, it became more and more difficult to convince our students or ourselves that it was not osteitis fibrosa. Then I began to see examples of latent bone cysts in the epiphysis and shaft of older people, two of which are pictured in my first article in this *Journal* in July 1926. The pathology of these three cases—the two reported in my first paper in this *Journal* and this now under discussion—is identical. Within the bone shell (Fig. 3) there was a thick leathery connective tissue lining, and within this a cavity containing clear fluid. The microscopic examination of the lining in all three cases is identical, as shown in Figure 4 (low power) and Figure 5 (high power). All three are either fibrosarcoma or osteitis fibrosa. As the two more recent cases were only curetted and now, almost five years since the operation, are free from symptoms, and x-rays show ossification, we must conclude that the lesion is benign. Therefore, should this patient whose x-ray is shown in Figures 1 and 2, come under observation today, we would be in a position to recognize the nature of the lesion and save the patient from amputation.

FIG. 8

Case 2. Pathol. No. 26593. Photograph of gross specimen in longitudinal section, through femur shown in Fig. 6. X—X are corresponding sides of the large cortical defect. But the periosteal tumor mass in Fig. 6 at X was removed in preparing the specimen. See how clearly the x-ray shows the pathology in Fig. 8.

CASE 2. (Pathol. No. 26593, Figs. 6, 7, 8 and 9.) Question as to central sarcoma of the lower end of the femur. No question as to spindle-cell fibrosarcoma. Death three years after amputation.

I am discussing this case second, because, histologically, there is no question that it must be looked upon as a spindle-cell sarcoma, of either the osteogenic or fibrosarcoma type. It was accepted by the Codman Registry as an osteogenic sarcoma. The specimen and history were sent to me by Dr. S. S. Gale of Roanoke, Va. From the x-ray picture shown in Figures 6 and 7 Dr. Gale and his associates made the diagnosis of sarcoma and performed an amputation through the thigh in 1920. At the end of two years and three months, we were

informed that the patient was well. Later, Dr. Gale wrote that he had been informed that the patient died in a sanatorium, date and cause of death not given. As the age of the patient at this time was almost eighty, we can not conclude that he died from metastasis to the lungs. In spite of long correspondence no further definite data could be obtained.

We have never been able to get a complete clinical history in this case, except that the patient was aged seventy-seven, and the amputation was in 1920. Dr. Gale was good enough to send me the specimen and the x-rays.

When we compare the x-ray plates (Figs. 6 and 7) with those of Case 1 (Figs. 1 and 2) we have a right to conclude that Case 2 could be a primary periosteal or diffuse sarcoma rather than a central one. It was the gross specimen (Fig. 8) which we received before the x-ray that suggested a central origin. Cases similar to this one illustrate the confusion in the literature and in all laboratories in the diagnosis of all cases of central and

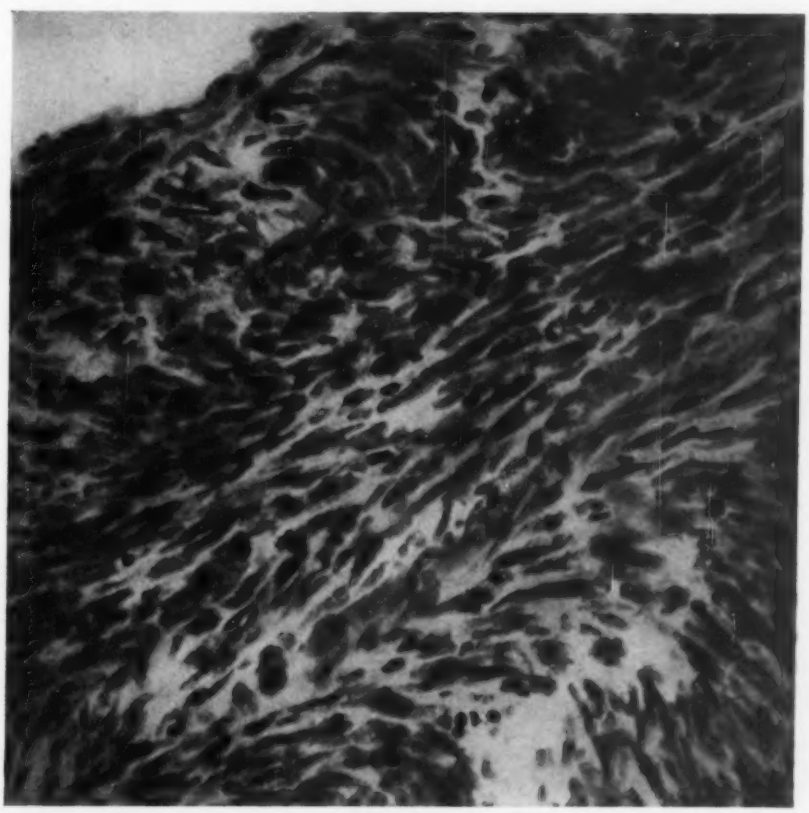

FIG. 9

Case 2. Pathol. No. 26593. High-power photomicrograph of section of tumor shown in Fig. 8.—Sarcoma, osteogenic type; spindle cells, somewhat in whorls, predominate. But this is not a pure spindle-cell tumor. There is no bone formation, no cartilage, no myxomatous tissue; practically no lymphoid cells; no evidence of perithelial or endothelial angiosarcoma.

periosteal sarcoma, so much so that Codman's Committee on classification were not willing to accept these differential terms, but my studies convince me that, for x-ray differential diagnosis, the terms *periosteal*, *central* and *diffuse* will be most helpful as descriptive terms, and these groups in the earlier stages have their different modes of attack.

Figure 9 is a high-power photomicrograph of Case 2. Spindle cells predominate. The number of fibroblasts and the intercellular eosin-staining fibrous tissue are not sufficient to place it in the fibrosarcoma group. I think we can justify ourselves and accept osteogenic sarcoma as a proper term.

CASE 3. (Pathol. No. 23407, Figs. 10, 11, 12, 13 and 14.) Microscopically (Fig. 13), there is a question between fibroma, fibrosarcoma and osteitis fibrosa. The x-ray and the gross appearance suggest a central tumor of the lower epiphysis and shaft of the femur. In contrast to Case 2, this patient is well six years after amputation.

In the clinical history there is nothing which helps in the diagnosis. I am not even convinced that the history is correct. All that is recorded worthy of consideration is that she was a white female aged twenty-nine, and the swelling of the external condyle of the femur had been observed for four months and began six months after an injury.

The x-ray taken before operation (Fig. 10) shows destruction of the lower end of the femur, epiphysis and shaft, leaving intact the joint surface, part of the internal condyle, a thin ridge of cortical bone to the inner side. The line of demarcation between the area of bone destruction and the remaining bone is not sharp as in the chondroma, giant-cell tumor. The complete destruction of the shell of bone on the outer side I have observed in giant-cell tumors. It would be possible also to have a primary sarcoma originating from the periosteum, growing into and destroying the shaft as in this case.

At the time of the operation this x-ray was interpreted as sarcoma and the leg amputated without exploratory incision. Even today, one would question the advisability of biopsy, because the area of bone destruction is so great that it would be difficult to restore function with bone transplantation. Nevertheless, in examples of this kind, we must prepare ourselves for the recognition in an earlier stage, in which there will be less destruction of bone and therefore an opportunity to eradicate the disease and save the limb. I wish to repeat here that experience since 1910 and even before shows that the x-ray in Figure 10 is not a typical picture of malignancy. A giant-cell tumor could produce it and even osteitis fibrosa and fibroma.

Gross Pathology. (Fig. 12.) The tumor pictured looked and felt more like a fibroma or a solid area of osteitis fibrosa, and solid osteitis fibrosa is just as certain a pathological process as the cystic osteitis fibrosa. But when I place together solid osteitis fibrosa, fibroma and fibrosarcoma, there is no way to differentiate one from the other in the gross. Fortunately, osteitis fibrosa occurs most frequently, as illustrated in Figure 3, as a cavity filled with fluid and between the bone shell and the fluid a zone of leathery fibrous connective tissue.

FIG. 10

Case 3. Pathol. No. 23407. X-ray, antero-posterior view. Note the destruction of the epiphysis and shaft with a thin zone of bone to the inner side and compare this with the gross picture in Fig. 12. The diagnosis from the x-ray was sarcoma, amputation was performed in 1920. The patient is well in 1926.

FIG. 11

Case 3. Pathol. No. 23407. X-ray, lateral view. This shows both the central tumor with sharp differentiation from the marrow cavity above and the periosteal tumor without bone formation. Compare Figs. 10 and 11 with Figs. 6 and 7 and note the impossibility of distinguishing central and periosteal in late stages when there are periosteal and central shadows.

FIG. 12

Case 3. Pathol. No. 23407. Photograph of gross specimen in longitudinal section through lower end of femur shown in Fig. 10. For photomicrographs see Figs. 13 and 14.

Of the numerous cases which I have studied (probably several hundred) I have never found, in fibrosarcoma, the single or multiple cysts which are usually present in osteitis fibrosa. When the cysts are absent, the differential diagnosis is difficult and when the lesion is in the adult and in the epiphysis, it is much more difficult to recognize osteitis fibrosa. The gross appearance in Figure 12 is entirely different from that in Figure 8, and I believe, from Figure 13 (low power) and Figure 14 (high power) we are dealing with an example of osteitis fibrosa. The unusual features in this case are the observation of the adolescent disease at the age of twenty-nine, its presence in the epiphysis and the complete destruction of bone on the outer side. It is fair to assume that, if this is osteitis fibrosa, it was present when the patient received the injury, and that the injury excited rapid growth in a pre-existing quiescent disease. I take this opportunity especially to call attention of the medical profession and industries and those dealing with accident insurance and workmen's compensation, to the difficulties of deciding whether the injury is the actual cause of the patho-

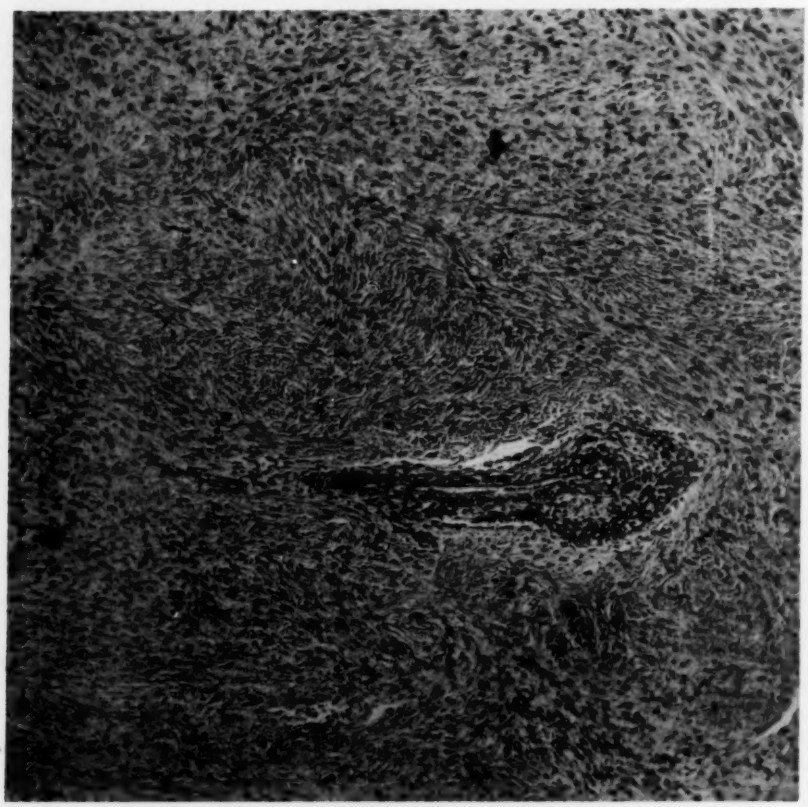

FIG. 13

Case 3. Pathol. No. 23407. Low-power photomicrograph of specimen shown in Fig. 12. With this power it is difficult to differentiate chronic inflammatory tissue from a possible fibrosarcoma. See Fig. 14 for high power.

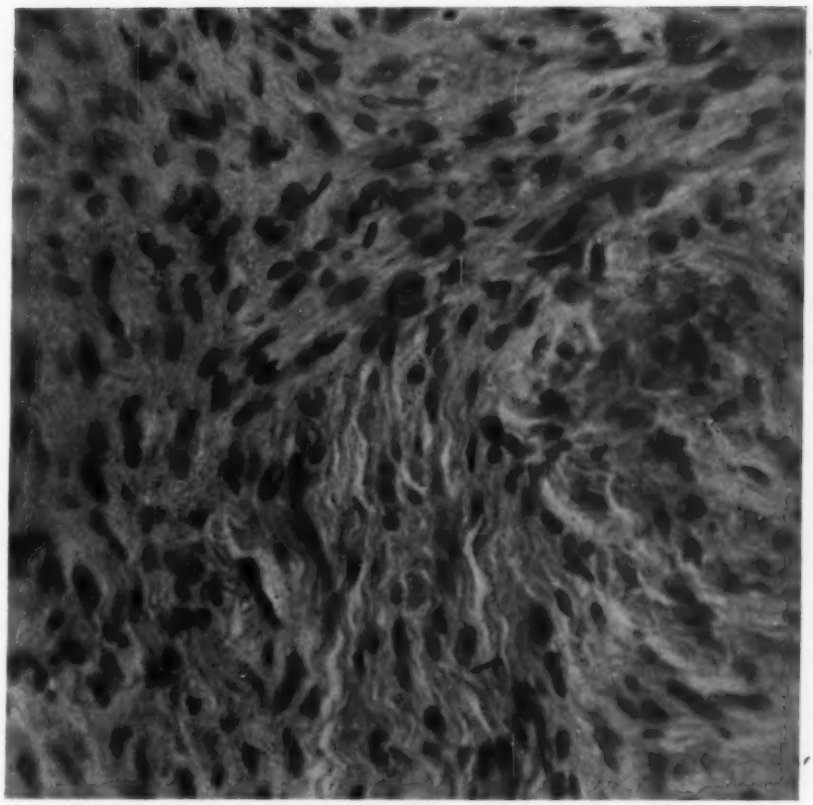

FIG. 14

Case 3. Pathol. No. 23407. High-power photomicrograph of area shown in Fig. 13. This has been diagnosed fibrosarcoma by many pathologists. My restudy favors osteitis fibrosa.

logical process and, if not, how much is the injury responsible for the rapid growth of the apparently pre-existing quiescent or latent disease.

It is also important to record here that we have many examples of solid osteitis fibrosa in the shaft of the bones of individuals under eighteen years of age, and these areas of fibrous tissue have only been removed with the curette and recurrences have not taken place. In one case, first observed and reported by Dr. Kammerer of New York, it must be almost thirty years, and due to the kindness and courtesy of Dr. Kammerer, I have an x-ray of this patient a few years ago.

CASE 4. (Pathol. No. 24746, Figs. 15, 16, 17, 18 and 19.) Osteitis fibrosa of lower end of femur involving the epiphysis. Resection and transplantation of piece of tibia by Dr. McKenty, of Winnipeg, Canada, in 1919. The patient is well in 1926, seven years.

In this case for some time the sections of the tumor were considered sarcoma of the fibrosarcoma type by a number of pathologists, and were first so classified in my laboratory.

FIG. 15

Case 4. Pathol. No. 24746. X-ray, anteroposterior view. Huge central tumor with intact bone shell, except for pathological fracture at junction with shaft. Probable diagnosis, huge bone cyst.

FIG. 16

Case 4. Pathol. No. 24746. Lateral view of case shown in Fig. 15. Pathological fracture through cyst clear. Line of demarcation with marrow sharp, suggesting bone cyst or chondroma.

This patient, aged 26, had a swelling for ten years. This itself indicated bone cyst. The small tumor became larger after a recent injury, and the pathological fracture took place ten days before these x-rays were taken. The patient is well seven years after enucleation of tumor and bone transplantation.

FIG. 17

Case 4. Pathol. No. 24746. Photograph of gross specimen removed from the bone shell shown in Fig. 16. Note the distinct capsule; observe the many smooth-walled cysts. This is the gross appearance of polycystic osteitis fibrosa.

The x-rays (Figs. 15 and 16) picture a very large expanding tumor of the lower end of the femur which seems to be distinctly central, although the bone shell is very thin. The pathological fracture shows best in Figure 16.

Gross Pathology. The tissues sent to my laboratory, with the x-rays, by Dr. McKenty were removed from within the bone shell and, as shown in the illustration (Fig. 17), are masses of fibrous connective tissue in which there are numerous cysts. I have just made the statement that I have never seen such cysts in sarcoma of the fibrosarcoma type. The cysts have smooth walls. They may be dilated lymph spaces. Whether the cyst is small or large, the content is clear or cloudy fluid. The consistency of the tissue in Figure 17 is practically identical with the lining of the cyst in Figure 3 and the solid mass in Figure 12. None of these three cases resembled the gross pathology of the sarcoma shown in Figure 8. No shell of bone was received with the specimen of this case (Case 4). In further correspondence with Dr. McKenty, I found that the disease was not given a margin sufficient for sarcoma.

There has been no recurrence now for seven years which is evidence

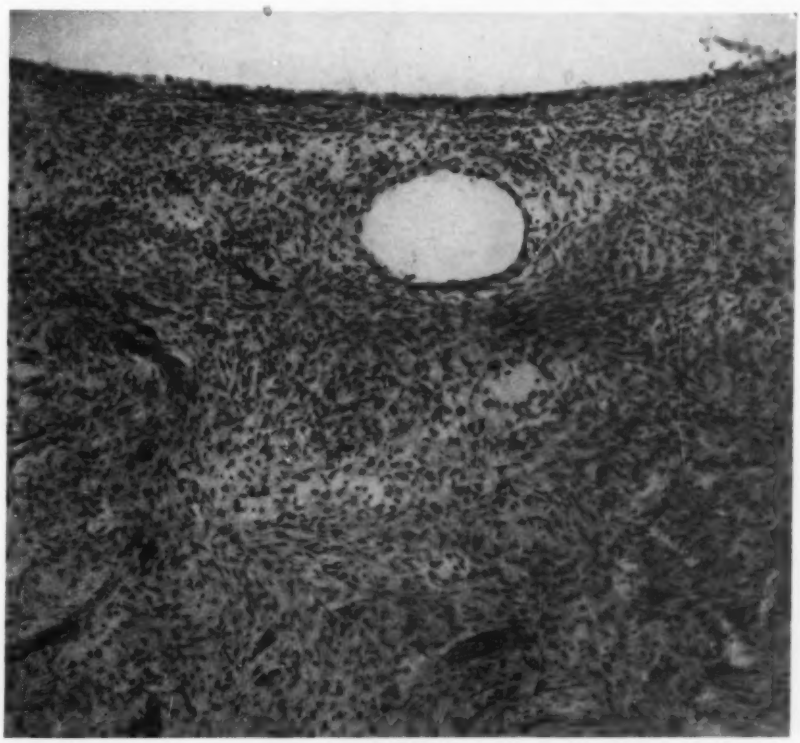

FIG. 18

Case 4. Pathol. No. 24746. Low-power photomicrograph of specimen shown in Fig. 17. Typical osteitis fibrosa, but frequently confused with sarcoma. For high power see Fig. 19. Note the small endothelium-lined cyst.

against sarcoma. The microscopic pathology as shown in Figures 18 and 19 is against sarcoma.

CENTRAL PRIMARY FIBROSARCOMA OF BONE

I have no proof that such a tumor has ever been observed, except in the lower jaw, and here I have examples of both, the fibroma and fibrosarcoma. In the lower jaw I have never observed osteitis fibrosa.

I have illustrated and described here three examples of osteitis fibrosa. The microscopic sections of these have been diagnosed fibrosarcoma. I am convinced that Cases 1 and 2 must be classed with osteitis fibrosa. Case 3 might be looked upon as a fibroma or a possible fibrosarcoma, especially from the high power shown in Figure 14. The fourth case used in the argument is Case 2 (Fig. 8), undoubtedly a sarcoma, but no positive proof of central origin.

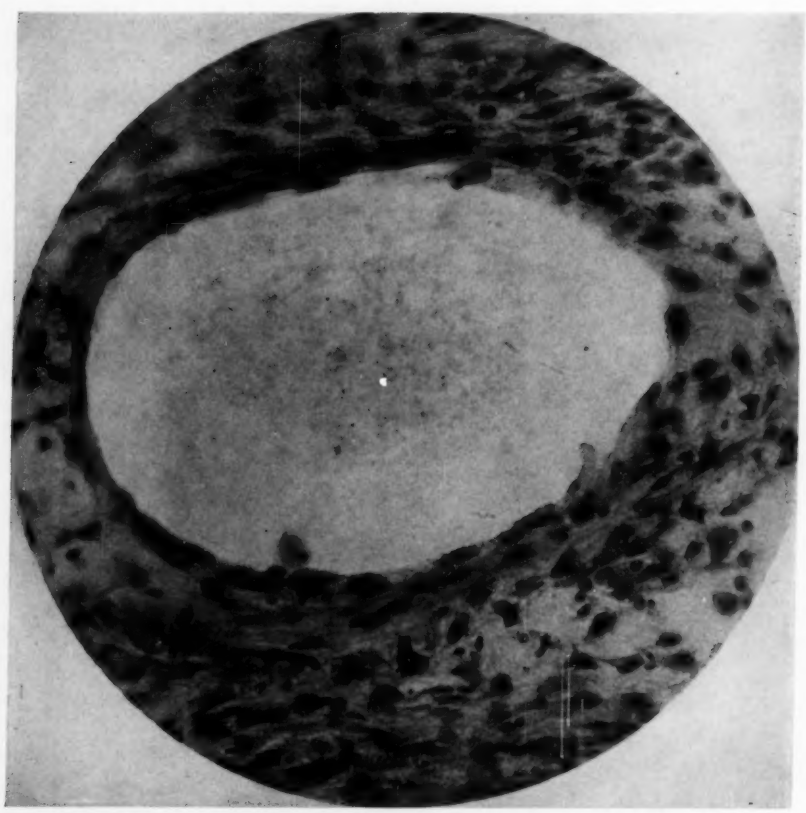

FIG. 19

Case 4. Pathol. No. 24746. High-power photomicrograph of area shown in Fig. 18. My diagnosis from this picture is osteitis fibrosa. But this tissue, especially in hardened sections is difficult to differentiate from sarcoma. See text. Note the endothelium-lined cyst shown in Fig. 18.

CONCLUSIONS

I have taken this third paper of the series to call attention that if you have in the x-ray a definite bone shell, and the bone destruction is all within that shell and there is no evidence, in the x-ray and on palpation, of any tumor formation outside the bone shell, and, at the exploratory incision, you find within the bone shell a mass of fibrous tissue difficult to distinguish from sarcoma in the gross and frozen section, you will be quite safe in concluding that you are dealing with osteitis fibrosa. Conservative measures are in order.

If there are many minute cysts, or one large cyst, this is evidence still more positive of the benign bone cyst (osteitis fibrosa).

If the patient is under twenty years of age, this is additional evidence that the lesion is benign.

As more adults are x-rayed for sprains and contusions, for slight pain or limp as well as for fracture, we may expect to see more and more frequently evidence of the single, healed or latent bone cyst, and after definite injuries these quiescent lesions may grow and produce conditions seen in Cases 1, 3 and 4, illustrated in this paper.

The predominant central lesions of bone are osteitis fibrosa and the giant-cell tumor. Next in order of frequency comes the metastatic tumor. Chondroma, myxoma and sarcoma, developing in one or the other or both, are not frequent tumors. The multiple myeloma without evidence of other bone involvement is a rare disease. It is time now for all of us to learn to recognize osteitis fibrosa and the giant-cell tumor in all their clinical, gross, microscopic and x-ray variations.

I trust the discussion of these four cases with their illustrations will be helpful, and I wish to repeat that up to the present time there is no positive evidence of a central fibroma or fibrosarcoma of bone, such as occurs in the lower jaw. If Case 2 had been seen with an intact bone shell and no tumor tissue outside the cortical bone, we would have definite evidence of a central sarcoma of the osteogenic type. But at present I have no evidence of such a tumor. The only type of central sarcoma is chondromyxosarcoma, which should be easily distinguished from the giant-cell tumor and osteitis fibrosa, and the very rare bone aneurysm which can be differentiated from the hemorrhagic giant-cell tumor in the frozen section.

BACK INJURIES IN INDUSTRIAL EMPLOYEES

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Back injuries in industrial employees are demanding ever increasing attention because of their frequency and tendency to produce prolonged disability. The almost universal application of insurance and compensation to such cases has led to a demand for more accurate diagnosis, prognosis and treatment. The following study is based upon the examination of 941 consecutive cases. They all came under the Workmen's Compensation Act and so drew compensation. All but a few occurred in coal miners. About half were seen almost immediately after their injury for the purposes of diagnosis and treatment, the other half being sent in after an interval of from a few months to five years to determine their condition and the extent of their disability.

These cases differ from the ordinary routine backaches because of the constant factor of more or less definite trauma as the exciting cause. They have been divided into eight groups according to the diagnosis made, namely: sprains, contusions, fractured vertebral processes, fractured vertebral bodies, deforming arthritis, neuroses, malingering and disease. The number and percentage occurring in each group is shown in Table 1.

TABLE 1

CLASSIFICATION OF BACK INJURIES

	No. of cases	*Per cent.*
Sprain	498	53
Contusion	122	13
Fractured vertebral processes	41	4
Fractured vertebral bodies	30	3
Deforming arthritis	107	11
Neuroses	11	1
Malingering	35	4
Disease	97	10
Total	941	

Percentages in most of the tables are figured without decimals.

SPRAINS

In 498 cases, or fifty-three per cent., the diagnosis was sprain. A strain is usually defined as simply overuse or stretching of the muscles or ligaments slightly beyond physiological limits without the production of structural change, while a sprain is usually regarded as overstretching to

the point of rupture of some fibers resulting in minute or extensive lacerations. Such a differentiation is purely arbitrary and very difficult or impossible to make clinically. For this reason injuries of this type have been grouped together under the general term sprain. Such sprains may involve the muscles, ligaments or joints or any combination of them, and are exactly similar to sprains occurring in any other jointed structure. However, as the back is made up of a relatively large number of small bones connected by more than one hundred closely set and often imperfect joints, and by a multitude of complex muscular and ligamentous supports, such sprains are likely to be followed by more widespread, serious and demoralizing results than occur after the same or even more serious injuries in other localities. In addition the back takes part in nearly every movement of the body and extremities, and consequently, if once sprained, is subject to almost constant irritation. For these reasons the treatment of such sprains is difficult and often imperfect, and improper treatment is frequently followed by a condition of chronic irritability of the structures involved. On the other hand, the back is so firmly and compactly built that under normal conditions it is capable of withstanding any ordinary amount of strain.

Back sprains usually occur directly from sudden or excessive muscular effort, but may occur indirectly from stretching of the spinal column beyond its normal arc. Among the miners nearly half the cases were caused by lifting or pushing pit cars. Most of the others were caused by lifting chunks of coal, rock, etc., practically all of them being ordinary lifts such as the men were accustomed to make many times each day. Only about a fifth of these two groups described any slip or unusual wrench. About ten per cent. attributed their condition to ordinary shoveling. About five per cent. of the sprains were received indirectly or passively. The remainder occurred in a great variety of ways. The extensor group of muscles and ligaments were practically always involved. In only two cases was there any suspicion of involvement of the flexor groups.

Sprains are most common in the more flexible portions of the spine. The most frequent site is the lumbosacral region where about two-thirds of the cases occurred. This is due not only to the relatively wide range of motion present, but also to the great leverage exerted upon this region by the rest of the spine and the lower extremities, and to the position of the fifth lumbar vertebra and sacrum which is such that it affords but little bony support, the whole strain of both weight and exertion being thrown almost entirely upon the adjacent ligaments. The next most frequent site is the mid and upper lumbar region where nearly a fourth of the cases occurred. Here, although almost as much weight is borne as by the lower lumbar spine and the leverage from the adjacent segments is almost as great, the vertebrae and their transverse processes are smaller and their ligaments weaker. In addition the articular facets of the vertebrae in this region tend to be set in an almost perfect lateral plane, that is, at right angles to the anteroposterior plane, so that there is no bony locking and

nothing but the ligaments to prevent one vertebra slipping forward on another. It is in this region also that the most concave portion of the thoracolumbar curve occurs, making the hollow of the back and corresponding to the waist, where the circumference of the back is the smallest. Finally, the thoracic segments of the spine above with their attached ribs are comparatively fixed and take but little part in flexion, so that it represents the junction of a relatively fixed with a movable portion of the back. These anatomical facts also account for this region being the most frequent site of severe sprains from extreme flexion of the spine, and also for the most frequent occurrence here of the injury known as fracture dislocation. The dorsal region, because it is relatively fixed, is very infrequently subject to sprain, only eight cases occurring here. The cervical region while quite mobile is seldom involved because of its position; six cases, all received indirectly or passively, are recorded. This distribution is shown in Table 2.

TABLE 2

BACK SPRAINS

Position and Disability

	No. of cases	*Per cent.*	*Cases with known disability*	*Average disability in weeks*
Cervical	6	1	2	5
Dorsal	8	2	6	1
Upper lumbar	110	25	86	3
Lower lumbar	273	61	180	5
Sacro-iliac	49	11	36	11

(These figures are not complete as the data in the records were not always complete. The cases with known disability are relatively small, because only those known to have returned to work are included. Some of the cases not listed were possibly more severe, in others the condition was complicated by industrial idleness and strikes. No attempt has been made to estimate partial disabilities. These statements apply to all the tables and lists of disabilities.)

The onset of symptoms may be as sudden as those from a blow, or the more pronounced symptoms may develop after an interval of a few or even several days. In about half the cases in which this point is recorded, the patients did some work after receiving their injury. The most frequent and pronounced symptom is usually pain. In addition there is tenderness, stiffness, limitation of motion and weakness in about the order given. In the more severe and acute cases there is frequently involuntary muscle spasm. The pain and tenderness are usually most marked at the site of the sprain, but show a definite tendency to be referred to the points of origin and insertion of the muscles, ligaments and fascia. After a short time these points may become the seat of chronic irritability and are then tender.

This accounts for the very frequent localization of symptoms in the lumbosacral region in all low back sprains. From here the pain is frequently referred to the buttocks and upper portions of the back of the thighs, and less frequently into the upper portion of the back. This is due to the fact that the posterior musculature is more or less continuous and posterior irritation is felt as pain both above and below the seat of the lesion. In about half the cases the lesion seemed to be unilateral or at least predominatingly so. In about five per cent. there was fairly typical sciatic radiation of the pain; more rarely there was radiation into the groin, testicle and anterior abdominal wall.

The mechanism of the production of this sciatic pain has been the subject of a great deal of interesting study. While possibly not entirely understood, it seems to indicate a deep seated and probably ligamentous injury and to result from nerve irritation or pressure from the adjacent oedematous and inflammatory reactions. From dissections Danforth and Wilson conclude that there is little likelihood of involvement of the lumbosacral cord from distention or inflammation of the sacro-iliac joint as its structures are too easily displaced, but that there is likelihood of involvement of the fourth and fifth lumbar roots either in their intervertebral canals or in the ligaments anterior to the lumbosacral region. They further point out that the distribution of the pain, sensory and reflex changes correspond fairly closely to that of the fourth and fifth lumbar roots.

It is impossible to accurately differentiate between lesions of the muscles and ligaments. Muscular lesions are probably more frequent, are more likely to follow simple exertion, to be unilateral and to show more superficial pain and tenderness. Passive movements usually cause little distress. Pain on straightening is very characteristic and often comes at a certain point in the form of a definite catch, while there is usually complete relief when quiet in the extended position. In ligamentous lesions the pain is more apt to be deep seated and to show an increase after an interval, while active and passive motions are both painful. The pain tends to be constant though considerably relieved by recumbency, particularly if a pillow is used to support the lumbar curve. Standing and sitting are usually irksome, and any active movement tends to increase the pain, particularly if it produces stretching of the injured fibers. On the other hand, passive backward flexion is usually painless. Long continued pain is often due to many additional but slight sprains occurring before the original scar has had time to heal. This means the constant accumulation of fibrous tissue and is likely to be followed by the development of adhesions. In lumbar lesions the stiffness and limitation of motion are most marked in forward and backward flexion and side bending, while straight leg raising is frequently limited and painful because it pulls on the damaged and irritable structures. In dorsal lesions these findings are usually most marked on rotation, while deep breathing and cough are likely to be painful. In only one case was there swelling at the site of the lesion. No cases showed redness, discoloration or other evidences of bruising, as the injured parts

are too deep seated to produce perceptible local changes. Roentgenograms were taken in nearly a fourth of the cases and, of course, were negative. In about five per cent. foci of infection were found, which were thought to be sufficiently definite to be regarded as possible or probable factors in delayed recovery.

In forty-nine, or about eleven per cent., of the cases just described the condition seemed to be sufficiently localized over the region of the sacro-iliac joints to warrant the diagnosis of sacro-iliac sprain. The sacro-iliac joints are true articulations. Their size varies somewhat, but in general the articular surfaces are fairly large, roughly ear-shaped, and situated in a generally vertical plane. The adjoining surfaces, although smooth and covered with cartilage and synovial membrane, present several irregular projections which fit into corresponding depressions in the opposite bone, producing a certain amount of interlocking. In addition to a short tight capsule the adjacent bones are held together by numerous ligaments of the heaviest possible variety. Unlike most other joints there is no muscular or tendinous support. There is undoubtedly a slight amount of normal motion in these joints. It is also admitted that this varies somewhat in different individuals, is greater in women than in men, and may be somewhat increased under pathological conditions. However, all the anatomical features of the joints are obviously designed to make them exceedingly stable. From the best accounts the motion measured at the symphysis varies from 4 to 6 mm. Measured at the joints themselves the excursion is about one-sixth this amount or 0.5 to 1 mm. It is evident that this exceedingly slight motion is not perceptible by any of the usual methods of examination. The sacro-iliac joints serve to transmit the weight of the body to the pelvis and thence to the legs. In addition they absorb much of the jar from walking, running, jumping, etc., and add to the movements between the trunk and lower extremities a certain amount of resilience which would be absent with a fixed bony attachment.

There was nothing characteristic about the type of injury. "Just as a twisted foot may cause a sprained ankle, so may a wrench from one cause or another sprain the ligaments holding together the sacrum and iliac bones." The sacro-iliac joints may and do share in this process, but to assume that there is a specific entity to be classed as sacro-iliac sprain hardly seems warranted by the evidence. That is, the sprain involves to a varying degree the general group of ligaments connecting the fifth lumbar vertebra, sacrum and iliac bones, and the involvement of the sacro-iliac joints is only a part of this neighborhood injury. The relatively frequent occurrence of such lesions is due to their anatomical position and structure. Their position is such that they are at the point of maximum motion in stooping and twisting, and they lie at the very fulcrum of the lever formed by the lower extremities and spine. They are the sole support of these joints. Unlike other joints the sacro-iliac articulations are not strengthened by either adjacent muscles or tendons.

Pain and tenderness are usually well localized about the affected

structures. The pain, however, is frequently referred along adjacent muscular attachments to the posterior portion of the thigh and in eighteen cases, or over a third, seemed fairly well localized along the course of the sciatic nerve, extending to the calf and heel or outer side of the foot. Compression of the iliac crests places additional strain upon the ligaments and usually increases the pain. In all but slight injuries the gait and attitude are fairly characteristic. The back is held rigid, slightly bent forward and to one side. Walking is guarded with the knee of the affected side slightly flexed and with a distinct limp. Lateral deviation of the spine is quite characteristic, and usually occurs away from the affected side. Forward bending is limited and during it the lateral deviation is increased and the knee on the injured side flexed. Side bending is also limited, and is usually more marked toward the injured side. Straight leg raising is limited on the affected side, while the same manipulation on the sound side causes referred pain on the injured side. In addition the normal lumbar curve is usually somewhat flattened. No cases of sacro-iliac relaxation, subluxation or slipping have been seen. That such a condition may occur during pregnancy or after severe crushing trauma is well known, but that it is a common cause of chronic backache after strain or otherwise is certainly not well established. The following are the most important points against such a diagnosis: First, the symptoms described are no different from those of simple ligamentous strain. The typical gait which accompanies demonstrably displaced joints, such as follow severe crushing injuries or infections, is absent. Second, the so called slipping or displacement described is not demonstrable either by palpation or x-ray. Third, there is no dissecting room or postmortem evidence that such a condition has ever occurred except in connection with pregnancy or severe crushing injury. Fourth, the anatomical structure of the joints and the ligaments about them render them so stable that even in severe crushing injuries to the pelvis it is the rule for the joints to remain intact while fractures occur in the adjacent bones. Although the dorsal narrowing of the sacrum gives it the theoretical position of an inverted keystone in the pelvic arch with its inherent weaknesses, this consideration is theoretical only as the arch is tied anteriorly by the junction of the ischial and pubic rami at the symphysis. This tie prevents the posterior arch opening. The efficiency of this arrangement is amply demonstrated by the well established fact that following crushing injuries, without regard for the direction of the crushing force, the anterior arch tends to give with fracture of the pubic or ischial rami, while the posterior arch remains intact. Fifth, the character of treatment which is said to give relief. This consists of adhesive straps, belts and various braces, and is probably of itself the best evidence of the incorrectness of the diagnosis. The sacro-iliac joints lie in a practically vertical plane and at each step bear the entire body weight which acts as a sliding downward thrust. No joint in the body once relaxed could be so unfavorably situated for recovery while the patient is going about. Moreover, the joints are deeply imbedded, so far as lateral pressure goes, in great masses

of fat and muscle. How then can they be jammed together or immobilized by such procedures?

The mechanism of all sprains is undoubtedly that of an incomplete or transient dislocation. The resulting ligamentous tears may be so complete that displacement occurs because of abnormal mobility, but unless the torn ligaments are repaired, why should the slipping structure remain replaced if it is manipulated into position, and why should not the displacement itself be capable of demonstration in the stereoscopic roentgenogram? Osgood sums up the matter as follows: "We do not doubt the evidence of sudden and sometimes permanent relief from distressing back and leg symptoms following manipulation of the spine with and without an anaesthetic. We have all performed these miracles and ought with the exercise of judgment to continue to perform them, but we must find some other explanation than the replacement of a displaced vertebral articulation when the stereoscopic roentgenogram reveals no difference in position in the films taken before the manipulation and those taken after."

In a more recent article Osgood and Morrison offer a more rational explanation of these rapid and often brilliant manipulative cures. They state that an acute injury is usually followed by an acute muscle spasm which is nature's protective response, and that this protective spasm may fix a muscle fasciculus or tendon or even a small articulation in malposition, and that this fixation then becomes crippling. Subsequent manipulation, either with or without an anaesthetic, restores the normal relationship with surprisingly sudden relief of symptoms and relaxation of the original protective and subsequently locking muscle spasm. It is needless to say that all such manipulations should be followed by a period of adequate fixation.

It is not always an easy matter to distinguish between low spinal and sacro-iliac lesions. In sacro-iliac cases when the patient is sitting forward flexion should be fairly free because of the support to the pelvis and relaxation of the hamstrings, while in low spinal lesions there will still be limitation. With the patient in dorsal recumbency flexion of the thighs on the abdomen with the knees bent should not be painful in sacro-iliac lesions because the pelvis moves more as a whole, but in low spinal lesions this movement may be expected to be painful because it produces tension on these muscles. In low spinal cases, a hand kept beneath the lumbar region while the thighs are flexed with the knees straight can detect the relation between the expression of pain or muscle spasm and movement of the spine.

No discussion of sprained backs is complete without the consideration of static or attitudinal strain. Static backache is a mechanical disorder, the result of loss of balance from displacement of the center of gravity producing local strain on the tissues of the lumbosacral region and posterior musculature, which is translated as ache and pain. There is no more difficult problem than the recognition of static backache in cases giving a history of trauma. Nevertheless twenty-one cases are grouped here either because of the relief afforded by treatment, the previous history of lame back with

almost negligible trauma, or the definiteness of the abnormality present. To these, for the sake of convenience, are added three cases in which the original injury consisted of a simple contusion. Sixteen were due to defects in lateral balance; nine were cases of shortening of a leg, six from fracture, and three apparently congenital; one case each from amputation of half a foot, ankylosis of a hip, congenital scoliosis, hemiplegia and poliomyelitis. Six cases were due to anomalies in development; four unilateral sacralizations of the fifth lumbar vertebra, one unilateral abnormality in the transverse process of the fifth lumbar with impingement upon the adjacent ilium, and one asymmetrical development of the fourth lumbar vertebra with scoliosis. There were five cases of anteroposterior displacement; two due to prominent abdomens, and one each to flat feet, shortened posterior leg muscles and paralysis agitans.

The prognosis in back strains should be as good as in sprains of any other joint. However, the participation of the back in practically every movement of the body and the impossibility of obtaining immobilization except in the recumbent position makes the period of pain and irritability more prolonged. The presence of general muscular weakness or bad attitude makes the back more vulnerable and recovery slower. Finally, in industrial cases such as these the necessity of returning to heavy manual labor without an intermediate period of light work makes the period of temporary total disability longer, as recovery must be practically complete before the men can resume work. The presence of inconsistent, contradictory or variable symptoms, the presence of neurasthenic or psychoneurotic manifestations, or the possibility of litigation or of compensation during periods of unemployment or slack work, make the prognosis difficult and unfavorable. Of the 498 cases, 309 were seen immediately or shortly after their injury and were treated until discharged. In 220 of these, slips were received from the employers stating that the patients had returned to work. Of these fourteen lost no time, the longest period of disability was thirty-six weeks, and the average period of disability two and five-tenths weeks. Twelve of the cases of sprain with static defect were treated with an average disability of about eight weeks. The remaining 189 cases were examined at variable periods after the accidents, either because of persistent disability or because they had filed claims for adjustment before the industrial commission, and obviously represented a somewhat selected group of more severe injuries. Of these, data are available in ninety or a little less than half. Of these, one had lost no time, the longest period of disability was seventy-two weeks and the average twelve weeks. The general average of the 310 cases in which the period of temporary total disability was known was approximately five weeks. The longest period of disability seen was ninety-two weeks, in a man who still claimed to be unable to work. The disability according to the location of the sprain is shown in Table 2. In Table 3 the cases are listed according to age and disability. In the last two columns are included only cases cared for personally during average working conditions, with sprains involving the middle and lower back.

These are undoubtedly more comparable than the whole group and show a very definite increase in the period of disability with advancing years.

TABLE 3

BACK SPRAINS

Age and Disability

Age	*No. of cases*	*Cases with known length of disability*	*Average disability in weeks*	*Cases cared for personally during 1923, 1924, 1925, with average working conditions*	
				No. of cases	*Average disability in weeks*
16–19	20	14	2	12	1
20–29	82	55	5	36	1⅜
30–39	110	73	5	47	2⅛
40–49	97	66	4	44	2⅝
50–59	48	35	4	31	3⅜
60–69	12	9	5	7	4⅜

The treatment employed has also been similar to that used in sprains of other joints. It has consisted of immobilization until the acute symptoms, such as involuntary muscle spasm and much pain or tenderness, have subsided. Most of the patients have been kept in bed during this period, with lumbar support and adhesive plaster strapping. In lesions well localized about the lumbosacral region surcingle strapping applied between the trochanters and anterior superior iliac spines has been used; in the other cases the straps have extended from below the shoulder blades to the sacrum. In muscular lesions rest should not be encouraged for much longer than three weeks. Where ligamentous lesions are present it is frequently necessary for six weeks or at times even longer, and subsequently support may be required during walking. After the acute period the use of heat, light and massage for a short time has been beneficial. Subsequently use, gradual but persistent, is best.

CONTUSIONS

Under the term contusion have been grouped those cases in which the back has been subjected to direct injury and the findings neither those of sprain nor fracture. In this group are 122, or thirteen per cent., of the cases. Over half of them were caused by falls of coal, rock or slate from the roof of the mines. The remainder occurred in a great variety of ways, the most common being falls and squeezes by, or collisions with, pit cars. From the nature of the accident described it was evident that the injury was severe in about half of the cases, in the others moderate or minor.

In this class of cases more than in any other, we are forced to reason from the etiology or mechanism to an indefinite pathology. The actual pathological changes can only be surmised. There may be superficial or deep contusions of the muscles or ligaments with or without lacerations,

injuries to tendinous insertions or ligaments, overstretching or rupture. Forced flexion, hyperextension or torsion may and frequently does add the factor of sprain. In the more severe injuries there is also the possibility of actual contusion of the vertebral bodies and intervertebral discs. Such a diagnosis, however, can only be made by the process of elimination, depends mostly upon the character of injury described and is nearly always speculative. The actual pathology can rarely be demonstrated. Most of the cases showed local evidences of bruising of short duration. None showed evidence of cord involvement. In the great majority of the cases the injury was to the lumbar region. A fair number involved both the dorsal and lumbar region, while only a few affected the dorsal or cervical regions alone. X-rays were taken in seventy-eight, or sixty-four per cent., and, of course, were negative. Five cases showed foci of infection which were thought to be sufficiently definite to be at least possible factors in the prolongation of disability.

Of the 122 cases, forty-two were taken care of until they returned to work. Six lost no time, one was off twelve weeks and the average period of disability was approximately two and five-tenths weeks. The remaining eighty cases were sent in for examination at varying intervals after the accidents and obviously represent a somewhat selected series of more severe injuries. In thirty-seven of these the period of total disability was known, the shortest being two weeks, the longest one hundred weeks, and the average twelve weeks. The longest period of disability noted was forty-one months.

The treatment, of course, varied considerably with the apparent severity of the case. Early it generally consisted of rest, support with pillows or pillows and sand bags, and the application of ice. In severe cases much comfort can be gained by the use of a Bradford frame. In the intermediary stage the support was continued and heat and light massage used. Later the massage was increased and gradual exercise begun.

FRACTURE OF THE VERTEBRAL PROCESSES

Fracture of the vertebral processes may be regarded as a connecting link between the lesser injuries of the back and the graver injuries of the spine. They may involve the transverse or spinous processes, the articular facets, or the laminae of the arches and are undoubtedly much more frequent than was formerly supposed. The dense paravertebral muscles make the palpation of deformity or crepitus impossible so that the diagnosis of their presence depends entirely upon the x-ray. Their more frequent recognition in late years has been due to the recent refinements in x-ray technique, notably the Bucky diaphragm, with the production of clear, sharply defined pictures. Even with these, mistakes will be made unless the interpreter is familiar with the peculiarities of the region involved. Confusion is most likely in questions of injury to the transverse processes. Here vague thickenings and deflections, or asymmetry of the axes of corresponding

processes, must not be regarded as evidence of a previous fracture. Another source of error is failure to recognize an ununited epiphysis, usually of the first lumbar, or the presence of a rudimentary rib on what one mistakes for the first lumbar but which is really the last dorsal vertebra. The sharp shadow cast by the psoas muscle as it crosses the bone may also be a source of error. Confusion in interpretation of injuries to the articular facets is usually due to poor centering of the tube, patient and plate. In injury to the neural arches, error is usually due to confusion of fracture with congenital abnormalities, almost always in the lumbosacral region.

Forty-one cases, or four per cent., showed fracture of one or more of these vertebral processes without evidence of other injury to the vertebral column. In thirty-six cases the fracture involved one or more of the transverse processes. There were two cases each of fracture of the spinous processes and neural arches, and one case of involvement of an articular facet.

The thirty-six cases of fracture of the transverse processes all occurred in the lumbar region. In the cervical region these processes are too underdeveloped to be injured, while in the dorsal region they support and are in turn supported by the ribs so that they are relatively well protected. Twenty-four cases, or almost two-thirds, were injured by heavy falls of coal, slate, rock or dirt upon the back. In eight or about one-third of these the fall was almost entirely on the shoulders producing an acute hyperflexion or jack-knife injury, the lumbar processes evidently being torn off by the unusual muscular pull. In four of the others this hyperflexion seemed to be the chief factor in the production of the injury. In three cases hyperflexion occurred beneath low places in the roof of the mine and beneath a pit car. In two cases unusual lifting strain was the only factor. In short, in seventeen or half of the cases the fracture was due to abnormal muscular pull, fifteen due to hyperflexion and two to lifting. This frequency with which indirect violence produces the fracture is not surprising when one remembers how deeply these processes are situated and how well they are protected from direct trauma by the dense muscles above them. The other nineteen cases were apparently due to direct violence. In twelve cases or about one-third the fracture was single; in twenty-four or about two-thirds it was multiple, that is, more than one process was fractured. Of the latter, nine was the greatest number broken in one case and three about the average. The right and left sides were almost equally involved. Of the individual vertebrae the processes of the third lumbar were most frequently involved, being affected thirty-four times. The second and fourth followed, being practically equally involved, and then the first and fifth, also about equally affected.

Of the seventeen cases due to the indirect violence of muscular pull, fourteen were multiple and three single fractures, and all but three showed displacement on the radiogram of more than a quarter of an inch, many being widely separated. Of the nineteen cases injured by direct violence few showed more than appreciable displacement. The pull of the quadratus

lumborum muscle usually produces slight lateral displacement of all fragments. In all of those in which there was slight displacement (less than a quarter of an inch as shown by the x-ray) there was evidence of callous formation and union in one to three months, that is, in approximately the normal time for small bones. Those fragments more widely separated, of course, showed no evidence of subsequent union. Of twenty-eight cases referred for examination only eleven or considerably less than half had been recognized. In twelve of the unrecognized seventeen no x-rays had been taken.

TABLE 4

LOCATION OF TRANSVERSE PROCESS FRACTURES

Left	*Lumbar*	*Right*
4	I	7
7	II	11
18	III	16
10	IV	12
4	V	4

The prognosis in those injuries due to direct blows without displacement of the fragments should be approximately the same as in fractures of other small bones, remembering that in a large jointed structure such as the back, the disability from pain and weakness will be more prolonged. However, there is no reason why these cases, with adequate treatment, should not be returned to some form of active labor in three months. In those cases due to indirect or muscular violence there is added the factor of muscular and ligamentous sprain with more or less extensive lacerations, the extent of which can not be definitely determined. Where the fragments have been separated any great distance, union does not occur with the result that some of the muscular attachments are permanently lost, but these and the function of the process itself are relatively insignificant. In sixteen cases the period of temporary total disability was known. The shortest period was two weeks, the longest fifty-four weeks, and the average twenty-four weeks. Of these, six cases had been adequately treated with an average disability of a little less than twelve weeks. The other ten had been poorly treated with an average disability of about thirty-one weeks. Nine cases of direct injury and seven of flexion injury had returned to work with an average disability of twenty to twenty-nine weeks respectively. The shortest period of disability, namely two weeks, occurred in a man with one process fractured by direct trauma. The second shortest period was five weeks in a case of hyperflexion injury with fracture and wide separation of four processes. Neither of these cases received any treatment and were known to have continued at their previous heavy work, namely digging and driving in a coal mine. Twenty cases had not returned to work at the time of examination. Of these, eight were seen within a few weeks after their injury, two cases were complicated by crushing injuries

to the pelvis and one by multiple fractures of the leg. A prolonged strike and lack of employment complicated the disability in four more. Of the remaining five, three had received inadequate treatment. Their average period of disability, which of course had not terminated, was fifty-six weeks.

There were two cases of fracture of the spinous processes, both due to direct violence from falling objects. One involved the third, fourth and fifth cervical vertebrae, the other the twelfth dorsal vertebra. Both were recognized. The disability in the first case was over three years, in the second twelve weeks. There was one case of fracture of one of the articular processes of the twelfth dorsal vertebra apparently from hyperflexion with rotation. It was recognized and adequately treated. The disability was eight weeks. There was one case of fracture of the lamina of the arch of the first cervical vertebra due to a fall on the head from a height of six feet. This case was unrecognized. The disability had been eight months and he had not returned to work. Another case showed a fracture of the arch of the first sacral vertebra due to direct trauma. It was almost two years before he returned to work. It is possible that these fractures of the vertebral arches are more frequent than we suppose, since here even the modern refinements of the x-ray may fail to give us the definite evidence required for diagnosis.

The essential treatment of fractures of the vertebral processes is that of fractures in general, immobilization. This can be properly obtained only in an adequate body cast supplemented by extension. This should be left on for about six weeks or as long as there is much pain, tenderness, muscle spasm or rigidity. Subsequently not a few of the cases, particularly the hyperflexion injuries, will require support from some form of brace for a few to several weeks. During this stage, or even before, physiotherapy in the form of heat, light and massage is of considerable benefit. Following this there should be graduated exercises with a return to some form of work as soon as possible. With this outline as a guide only fifteen cases or less than half could be said to have received adequate treatment. This is not as surprising as it would seem when it is remembered that only half of the cases were recognized. Eight cases had received what was obviously inadequate treatment, namely, a short rest in bed, adhesive plaster strapping and local applications of heat. Thirteen had received no treatment at the time of examination unless liniment and pills could be classified as such. In these cases the disability from pain may be indefinitely prolonged. However, this disability would seem to be more the result of the associated ligamentous strain than the bony injury itself. Excision of the bony fragments is unnecessary.

FRACTURES OF THE VERTEBRAL BODIES

With the increased availability and use of the x-ray and the recent refinements in its technique, it has become recognized that fractures of the vertebral bodies are relatively common and often follow what seem to be slight accidents. Many of these fractures are surprisingly devoid of

symptoms. The patient complains only of a stiff and painful back with some tenderness about the site of the fracture. As a rule the cord escapes injury as most cases are without displacement and occur below its level. Somewhat more frequently there is involvement of one or more of the nerve roots with neuralgic pain, changes in sensation and reflexes, or weakness or paralysis. In many cases this involvement is transient due to swelling, oedema or hemorrhage which is fairly rapidly absorbed. However, in the majority of cases nerve involvement is lacking and the diagnosis of such fractures can only be surely made and their location accurately determined by an x-ray taken from the front and also from the side.

The most common type of injury is the crush or compression fracture in which the violence is applied indirectly either from forced flexion or through the long axis of the spine. Hyperflexion from the fall of a heavy object upon the bent shoulders where the individual is in a stooped position is the most common mechanism. The spine gives way not at the point struck but at the angle of greatest flexion, that is, near the point of juncture of the fixed and movable portions of the spine. There results an impaction of the spongy portion of the vertebral bodies, a crushing together of their upper and lower surfaces so that their height is diminished and their width increased. As the spinal arch is made of compact bone, and the force exerted on the anterior portion of the column, it usually escapes injury. Severe injuries of this type are frequently followed immediately by the development of a more or less acutely rounded posterior knuckle or kyphos. This is one of the most important diagnostic signs as it can mean only one thing, destruction or distortion of the vertebral body. In less severe injuries the original trauma produces a stellate fracture of the vertebral body without compression. In such cases the knuckle appears after a longer or shorter period of time due to softening and absorption of the vertebral body with compression from the weight of the upper portion of the trunk, especially when the individual is up and about without proper support.

Thirty cases, or three per cent., showed fracture of the vertebral bodies. Twenty-five of these were struck on the back by heavy objects, one by the scoop of a concrete mixer, the others by falls of coal, rock or dirt from the roofs of mines. In the majority of these cases the men were caught while in a stooped position. Five were injured by falls of between seventeen and forty feet, three landing on their feet and two on their buttocks. In twenty-four, or eighty per cent., the force was applied indirectly; nine cases of pure hyperflexion or jack-knife injury, eight cases in which the hyperflexion was accompanied by some direct trauma, five cases of falls upon the feet or buttocks and one case each of rock falling upon the head and shoulders while the men were standing erect. The last case is quite interesting as it illustrates in a very typical way the general features already mentioned. A miner was pushing a rock weighing about two hundred pounds up a steep incline when his feet slipped and the rock rolled back against his chest and shoulders. He continued to work for

three or four days when he quit because of increasing pain. A month later he noticed a slight knuckle in the lower dorsal region. All of these cases showed distinct crushing of the vertebral bodies, sometimes slight and asymmetrical, sometimes almost complete. The most characteristic deformity was a distinct wedge-shaped crush with the apex of the wedge anteriorly. It is this type of fracture that is so frequently missed when lateral x-rays are omitted, as anteroposteriorly the body of the vertebra may appear practically normal. Six cases, or twenty per cent., were injured by direct violence. One case examined early showed two distinct cracks. The cases seen later showed more or less distortion, areas of increased density and proliferative changes, often with narrowing or obliteration of the intervertebral spaces and ankylosis. These changes were shown more plainly in the anteroposterior pictures, the vertebral bodies in the lateral views appearing almost undisturbed. Thirteen of the fractures involved a single vertebra, seven involved two vertebrae. In six there was slight rotation to one side or the other and in eight there were fractures of one or more of the transverse processes. The vertebrae involved are shown in Table 5.

TABLE 5

LOCATION OF FRACTURE.	NUMBER OF TIMES INVOLVED
Fifth cervical	1
Eleventh dorsal	1
Twelfth dorsal	4
First lumbar	12
Second lumbar	4
Third lumbar	7
Fourth lumbar	7
Fifth lumbar	1

Twenty cases, or two-thirds, gave no history or showed no evidence of any nerve involvement. Of the other ten cases three gave a history of transitory disturbances in the control of the bladder or bowel; one gave a history of and two showed slight sensory changes over the outer side of one leg with changes in the tendon reflexes, and one still had a little trouble with his organic reflexes. Two showed evidence of partial and one of complete cord involvement. Nine cases, or approximately one-third, showed a more or less distinct posterior knuckle. In four this developed immediately after the injury; in five, from one to six weeks later. Twelve of twenty-four referred cases were unrecognized prior to examination. In six there had been no x-rays, and in four only anteroposterior x-rays.

The prognosis, of course, varies markedly with the extent of the injury. Bony repair, however, is usually excellent, and, although there may be some stiffness, the supporting function of the spine is generally good, even in spite of a kyphos. Cases with much cord involvement are naturally permanently incapacitated and not infrequently these patients die, usually from urinary infection. On the other hand, cases without nerve

involvement seem to have a much better outlook than is generally recognized. In eleven cases, a little over a third, the patients were known to have returned to some form of active labor in the mines. Only three of these were wearing any form of support. In ten of these cases the period of temporary total disability was known, the shortest being five, the longest seventy-two, and the average about thirty-four weeks. The case which showed a disability of only five weeks was a compression fracture of the second lumbar, unrecognized and untreated; the patient had continued to work for several months and was almost symptomless at the time of examination. Of the other ten, one died in a few hours and another of urinary infection in nine months; six were obviously totally and permanently disabled; four seemed to be in sufficiently good condition to enable them to do at least some form of work and eight were too recent to allow conclusions.

Here again the treatment should be along the well recognized lines for fractures in general. This consists of early and adequate fixation, at first in a plaster shell, later with some form of brace. Offhand treatment may carry with it a definite threat of secondary cord injury. The length of fixation in these fractured spines without nerve involvement is of the greatest importance. Too short a period is likely to be followed by persistent or increasing symptoms, possibly increasing deformity and even aggravation of callous formation and nerve involvement. On the other hand, too long fixation may lead to muscle atrophy, stiffness, adhesions and contractures, exactly similar to those following too long fixation about fractures of the extremities and much more difficult to overcome. The most satisfactory management probably lies between these two extremes: namely, complete fixation for a period of six to eight weeks, followed by rest in bed, with some support for two to four weeks longer and with massage and application of heat; this in turn to be followed by gradual use with some form of brace, the latter to be applied till local muscle spasm and rigidity have disappeared. Here, as in fractures of the vertebral processes, prolonged disability is probably more often due to extensive injuries to the adjacent ligaments and muscles than to actual bone involvement. Roger's recent report of eight cases of compression fracture treated in this way with an average disability of six months is most encouraging. The chief criticism of the treatment given to the recognized cases was that the plaster shell applied was usually too short to give adequate fixation.

CHRONIC DEFORMING ARTHRITIS

By chronic deforming arthritis is meant the chronic form of arthritis recognized roentgenographically and postmortem by the presence of cartilaginous and bony outgrowths at the margins of the articular cartilages, at or about the lines of attachment of the capsule. It is primarily a chronic infectious disease. There is little to support the claim of some writers that it is either metabolic or arteriosclerotic in origin. The chief

etiological factor, therefore, is a focus of infection. These foci become the source of a bacteriemia of varying intensity for a period or intermittent periods of time. The organisms reach the joints through the blood stream lodging in the periarticular tissues, the subserosa or in the terminal branches of the nutrient artery which ends in the epiphysis. There follows more or less inflammatory reaction with swelling, exudation and endothelial and fibrous proliferation. This is followed later by secondary sclerosis and retraction which further interferes with the blood supply and nutrition of the parts. Repeated doses of bacteria cause renewed and increased damage so that finally, as a result of ischemia and malnutrition, there occur secondary degenerative changes with new bone formation due to faulty metabolism. Whatever the nature of the infection the resistance to it is always relative and never absolute and may be diminished by a great many factors, such as overwork, excessive fatigue, insufficient food, chronic disease, prolonged exposure to wet and cold, and the wear and tear of life. Such factors may be classified as secondary etiological agents and may be either general or local. The most frequent general factor is probably arteriosclerosis. The most frequent local factor is habitual trauma. By habitual trauma is meant the oft repeated slight injuries such as occur in laborious occupations requiring constant, long continued strain and overuse with its resultant articular stress. There is no evidence that a single isolated trauma ever produces true chronic deforming arthritis.

The symptoms of chronic deforming spondylitis are those of a low grade chronic inflammation. The first signs noted are usually described by the patients as "lame back". The back is uncomfortable and certain motions are painful. The pain is usually in the back, but at times is referred to the buttocks and lower extremities. There are recurrent attacks of lumbago, sometimes slow in their appearance, sometimes developing suddenly after a quick move or exertion. These last a few days as a rule and improve, but the patient does not get quite well and after each attack is less comfortable and complains of pain when he straightens up or lifts. Catches frequently occur after slight movement. Stiffness appears particularly in the morning and after resting, while the back tends to "loosen up" under use. This state of affairs may continue for years with variable periods of more or less acute exacerbation, or more or less complete remissions. There is, however, a definite tendency to recurrence and gradual progression.

The x-ray appearance is very characteristic and allows the diagnosis to be made with almost complete certainty. The first changes are probably bone atrophy shown as an uneven, mottled or stippled vertebral shadow. Marginal exostoses, however, develop quite early. They are usually shown first as small pointed growths prolonging the upper and lower margins of the vertebra. Later there is distinct lipping, spur formation and the development of large osteophytes, while the intervertebral space is narrowed or lost. These changes are frequently seen better in lateral than in anteroposterior pictures.

One hundred and seven, or eleven per cent., of the cases were placed in this group. The age incidence is shown in Table 6. This concurs with the generally recognized fact that the disease is most common in the fourth, fifth and sixth decades. The single case occurring in the second decade is very unusual but presented perfectly typical clinical and radiological findings.

TABLE 6

AGE INCIDENCE OF CHRONIC ARTHRITIS IN 105 CASES

Age	*No. of cases*	*Per cent.*
21–30	1	1
31–40	8	8
41–50	20	19
51–60	46	44
61–70	26	25
71–80	4	4

All of these men gave a history of a trauma of some sort to which they attributed their condition. Approximately half of these were in the nature of simple exertions such as they had been accustomed to perform each day in the course of their employment. In only a few of these was there a history of an unusual exertion, slip or unexpected strain. About a fifth were simply taken with a sharp catch while stooping, straightening, or turning, without strain or stress. Almost the same number described contusions, almost all of which were evidently slight. About ten per cent. attributed their condition to ordinary falls. Two described minor blows on the head. Two sneezed. About a third continued to work from a few hours to several days after their alleged injury. Approximately seventy per cent. denied previous trouble of any kind referable to the back. About fifteen per cent. admitted one or more previous sprains with intervening asymptomatic periods, while ten per cent. gave a more or less typical history of chronic or intermittent lame back.

Practically all complained of more or less pain. This was usually described as a dull persistent ache, becoming worse on active exertion and also increasing on continued quiet, to be again temporarily relieved by moving about. In sixteen cases there was distinct radiation of this pain; five anteriorly into the abdomen, four into the groins, two into the testicle, one generally into the back of the legs, and four of fairly typical sciatic distribution. In twenty-five cases, seen several months after the onset, there was a definite history of progression. In six there was slight lateral deviation of the spine and in four a slight rounded kyphos. One or more radiograms were taken in every case. All of these showed definitely the characteristic changes already described. In approximately ninety per cent. the involvement was limited to the lumbar spine and was diffuse in character. The second, third and fourth vertebrae showed the most marked changes. The involvement of the dorsal spine was limited to its

lower half and was always accompanied by changes in the lumbar vertebrae. In three cases there was every reason to believe that one of the osteophytes growing into the intervertebral ligaments had been fractured.

Forty-four cases showed distinct sclerosis of the peripheral arteries. This does not include slightly palpable arteries such as might be expected to occur more or less normally in individuals at or past middle life, but only definite thickening of the vessels, with abnormal tortuosity or beading or both. Twenty-eight of these showed a blood pressure above 150 mm. of mercury. Eighteen of these later also showed recognizable enlargement of the heart with a definite systolic murmur over the region of the aorta. Forty-eight cases showed definite chronic foci of infection. There were thirty-one cases of marked dental caries and pyorrhoea, in twenty-seven of which multiple apical abscesses were demonstrable by the x-ray. Seven cases showed definite evidence of chronic infection in the tonsils. Ten cases showed chronic bronchitis, and two chronic nasal obstruction with polypi and pus. Cases of slight or moderate pyorrhoea and dental caries, such as are so frequently seen in patients of this class, are not included. There were also nineteen cases of hypertrophied prostate all of which gave symptoms of slight urinary obstruction. In six of these the urine showed pus. Sixteen cases showed static abnormalities in the feet and one marked bowing of the legs. In short, almost half the cases showed definitely the general predisposing factor of arteriosclerosis, and approximately the same number gross foci of chronic infection. In addition, fifteen per cent. showed static abnormalities of the feet, such as might well have interfered with the weight-bearing function of the spine, adding additional habitual trauma to that of their occupation. Grouped, about half the cases showed definitely the general predisposing factor of arteriosclerosis; one-third of these foci of infection and one-tenth static abnormalities. One-third showed foci of infection and of these about a fifth showed static abnormalities. About five per cent. showed static abnormalities alone. Less than ten per cent. were without obvious etiological defects. In view of the fact that practically all of these examinations were made in the office, that many of the cases were seen only once or twice, that practically none of them were available for continuous or intensive study, and that only grossly obvious defects were listed, the percentage is astonishingly large.

Although all of these cases gave a history of some degree of trauma, either strain or contusion, they are grouped under chronic deforming arthritis not only because of the definite physical and x-ray findings described but because of their clinical course. Routine x-ray examination of all back injuries would undoubtedly have shown early arthritic changes in some of the cases whose history, examination and clinical course led to the diagnosis of simple sprain. These cases, however, all described evidently minor traumas, showed flattening of the normal lumbar curve, stiffness and limitation of motion in all directions, distinct x-ray evidence of chronic deforming arthritis, and failed to clear up as one would expect from the character of injury described. When it is remembered that

chronic deforming arthritis is a disease subject to more or less acute exacerbations without relation to exertion, it seems more than probable that many of these cases suffered no accident whatever, their condition being entirely referable to their disease. It is easy to trace the mental processes of a patient who after a hard day's work honestly concludes that his "lumbago" has its origin in his employment. Such an individual is hardly a malingerer but rather the victim of a false misconception, the more deep rooted because of tactless disputes at previous examinations. On the other hand, it must be admitted that the presence of arthritic changes renders the spine a damaged machine easily strained and sprained and then likely to become painful, so that in view of the history of some sort of an injury and the fact that the man was working up to that time, a certain traumatic element must always be admitted even though at times it seems improbable.

A spine, the subject of osteo-arthritis, will allow motion only through a limited arc, not so much because of the changes in the vertebrae but because of the involvement of the adjacent ligaments which become inelastic and often calcified. This restriction in motion may develop so gradually that the patient unconsciously adapts himself to the limited motion and may be entirely unconscious of it, provided no sensitive spot develops to attract his attention. Motion forced beyond this arc may then result in serious consequences. This fact, with its obvious relation to the production of pain and disability in such backs, does not seem to have been fully appreciated by many physicians. Osler has said that a man is as old as his arteries and to this Magnuson has added that a workingman's back is as old as its ligaments. The greatest difficulty is met in attempting to determine when the disability from the alleged injury ceases and that from the arthritis commences. To this there is no definite answer and yet the physician is often asked to give one. The answer is largely a matter of opinion in the formation of which the most important facts are the previous history, the character of the accident described, and the degree of arthritis present as shown by the x-ray. The history of the previous condition of the back is extremely important and must be carefully elicited at the start before those peculiar psychological changes, which accompany the possibility of litigation, have a chance to develop. Of the men seen at once, nearly two-thirds gave a history of previous lame back with stiffness, limited motion and periods of disability unrelated to exertion. Of those seen after claim had been filed, none gave such a history. As our work has continued, we have found that many of the men in whom the x-ray shows arthritic changes report again and again with "sprained backs" and that more than a few return with "lumbago" during periods of idleness. Obviously, the companies are responsible only for the restoration of the previous condition. Two well recognized facts must be remembered. First, that the x-ray does not reveal formative changes unaccompanied by calcium deposits, so that the actual arthritic changes present are always far in excess of those shown in the pictures. Second, that arthritic spines

show a marked tendency to stiffen up under rest, and that following recovery from a trauma the restoration of the previous functional condition can only be accomplished by use.

The treatment of these cases has been limited almost entirely to local measures, similar to those described under sprains and contusions. For obvious reasons the companies have not felt obligated for anything beyond the immediate traumatic element. The few cases in which general measures, such as the eradication of foci of infection, have been tried have been almost uniformly discouraging. In cases of long duration the men are not content with improvement or restoration of their previous condition, but seem to demand new backs!

In only fifty-two, or half the cases, was the period elapsing before the resumption of work known. In these the average period of disability was fifteen weeks.

NEUROSES

A traumatic neurosis has been defined as a combination of symptoms referable to the nervous system, which follow an injury, but which are not the result of organic lesions. Recently, the tendency has been to term these conditions simply *neuroses* as the word *traumatic* suggests an idea that is absolutely at variance with the commonly accepted medical opinion. The term "compensation neurosis" has been suggested but it too has its limitations. It stresses the fact, however, that compensation quickly terminates the period of idleness in such cases.

The manifestations of these neuroses are usually predominatingly hysteric in type, but are also partly neurasthenic and partly hypochondriac. They may include any degree or combination of involvement of the sensory or motor systems, the special senses, the vegetative nervous system, and psychical disorders, and are far too varied to be discussed in detail. Nevertheless they marshal themselves into a sufficiently distinct grouping to be accepted as a clinical entity. The origin of these symptoms is emotion and the emotion is fed by suggestion. Some of this suggestion comes from the patient himself. If one fears disability he becomes introspective and attentive to his general sensations. Much of the suggestion comes from without. Consoling, anxious and oversolicitous friends and relations, injudicious examinations by physicians and re-examinations without end, conversations with attorneys, repetition of symptoms in court, observation of and acquired knowledge concerning other patients, all contribute to the hypothecated picture. Lennon has shown that careful and continued study of these cases, particularly when aided by the investigations of a competent social welfare worker, invariably shows some inherent abnormality in the make-up of these patients which causes them to react in the way they do; in short, that adequate insight will always reveal an individual who is decidedly neurotic. The patient, however, is not the only factor. If others did not act he would invariably recover.

The fundamental condition is really a disorder in conduct occurring in

individuals who are fearful, dissatisfied and who seek compensation. Their condition results not so much from the accident as from the erroneous opinion they have formed of the nature and extent of that accident, and of the rights to which they are entitled, persuading themselves that an income is necessarily due them. Thus, in the last analysis the real factor which fosters their condition is the desire for compensation. It is the opinion of contemporary neurologists that were it not for this possibility these neuroses would not exist, except in those rare cases in which there are other situational factors which cause the patient to wish to remain ill, and which would have produced hysteria even if an accident had not occurred.

The diagnosis of a neurosis can only be made by exclusion. It is needless to state how painstaking must be our efforts to eliminate all possible organic disease. We must constantly guard against the fallacy of assuming that because no organic lesion can be found, it is necessarily absent. The greatest difficulty comes in differentiating a true neurosis from malingering. A malingerer is a wilful imitator of disease for the purpose of gain. Babinsky has said that between the manifestations of fraud and those of hysteria there is only a moral difference. Thus, in hysteria the patient is not aware of the illicit motive behind his symptoms, while the malingerer is. However, to introduce the criterion of a moral difference between hysteria and fraud is only to resuscitate the whole question in the form of an inquiry into the psychology of belief. Unless there is sufficient evidence at hand to definitely answer this question it is safest to maintain a purely objective viewpoint and merely attempt to determine the extent to which the patient is dominated by his neurosis. An individual who is really dominated by a neurosis and suffering from it will corroborate his subjective symptoms by certain objective signs of disordered function. These signs may be roughly divided into five groups: first, poor general condition as evidenced by weight loss, flabby muscles, sallow skin, anaemia, and general weakness; second, increased excitability of muscles and nerves as shown by the presence of tremors and increased tendon reflexes; third, disturbances in the realm of the autonomic nervous system such as palpitation, tachycardia, flushing, sweating and other vasomotor abnormalities, respiratory irregularities and gastro-intestinal disturbances; fourth, sleep disturbances usually with nocturnal fright; fifth, certain psychical disturbances, the most frequent of which are general irritability, dispositional depression, fear states and phobias. A social diagnosis is often as much needed as a medical one. Finally, it must be remembered that a traumatic neurosis is a convenient term which has hypnotized judges and juries even as the so called shock has hypnotized the plaintiff. Mayer states that at least twenty-five per cent. of the traumatic neuroses which get into court are pure simulation.

The first essential in treatment is an early correct diagnosis. The chief function of the doctor is to make this diagnosis, not to treat. Treatment is entirely futile during the time of litigation as they are not fighting for health but for a reward. Careless and ignorant diagnoses and repeated

examinations are to be avoided. Fear arises from a lack of knowledge of the real significance of the phenomena present. For this reason, a grave injustice is often done by the doctor who is afraid to say that no organic disease is present. Anxieties follow and if these are regarded too seriously the seeds are sown for the development of a post traumatic neurosis. The second essential is a quick return to some form of work with a continuous, intelligent and patient effort at rehabilitation by labor. There should be a definite and final determination of the period of disability. Examination and re-examination, fixing and refixing the period of temporary disability is as sane a procedure as repeated partial excision of a malignant growth; it only stimulates the morbid process. The third and most essential element is that of compensation. Since it apparently can not be dispensed with entirely, it should be given in as innocuous a form as possible. This is undoubtedly an early, final, lump sum settlement granted with as little litigation as possible. The quicker the patient recovers, whatever the initial cost, the less will be the expense. The patient with a compensation neurosis will recover when the irritating element of gain has been removed from the etiological complex and only then. Set a definite limit to the period of compensation and you have also fixed the date of recovery. But after all, one can not help wondering if a disease that is so curable with gold is really a disease or a swindle! And yet in those individuals who are actually neurotics or inferiors the injury may arouse a pre-existing tendency and cause prolonged disability, not on account of the injury but on account of the underlying defect, an aggravation of a pre-existing condition.

Eleven cases, or one per cent., were classified as neuroses. All showed to a greater or less degree the classical findings listed in current text books. Two men were struck by falls from the roofs of the mines. Both had been able to walk out and subsequently had been up and around continuously. Two others had similar but more severe contusions necessitating short stays in the hospital. One fell thirty-five feet and was evidently considerably shaken up. His recovery was also evidently proceeding satisfactorily when a physician made a diagnosis of enteroptosis and told him, "his whole insides had been jarred loose and fallen down and that he could never work again". His neurotic symptoms dated from that examination. One was in a collision and was told that his injury had produced a tuberculosis of the spine and that he was permanently incapacitated. One slipped and fell. One was knocked down by another man and continued to work till told by his physician that he was seriously injured and should sue the company. One lifted a twenty-five pound chunk of coal and was told that he had suffered a severe ligamentous strain that would be months and months in healing. One who claimed an injury from an ordinary lift was subsequently drowned in a few feet of water while drunk. One helped lift another man who had been seriously injured. With the exception of the last mentioned case none of the men were at work. The longest period of disability had been fifty-six weeks, the average forty weeks.

EXAGGERATION AND MALINGERING

From the first concept of industrial medicine, traumatic backache has enjoyed an unenviable reputation among insurance companies, employers and physicians. This has been due to a lack of the proper understanding of the nature and extent of such injuries, their relatively slow and tedious recovery, the almost universal absence of visible evidences of injury, and the frequent presence of exaggeration and malingering. While practically all individuals are able to understand, at least in a general way, the nature of injuries to the extremities, back injuries appear obscure and full of dire potentialities, not only because of the complexity of the structures involved but because of the nearness of the spinal cord. The absence of visible evidences of trauma at any time in most cases, and in practically all cases after the first few weeks, is as evident to the individuals as to the physicians, so that they soon realize that they have little to prove their disability other than their own statements. This fear of a serious injury entailing more or less permanent disability, the feeling that their condition is not properly understood, the suggestions of consoling, anxious, oversolicitous relatives and friends, injudicious examinations and statements by physicians, and the depression accompanying their slow progress of recovery, and enforced idleness lead to the natural exaggeration of symptoms in order that they may gain proper recognition of their condition. To this is frequently added the inability or unwillingness to differentiate between a disabling condition and one of mere discomfort which would nevertheless permit the resumption of work. This factor is inextricably interwoven with the factor of compensation which presents to the individual an opportunity of gaining monetary advantage from misfortune, especially during periods of slack work or industrial idleness. Everyone who has dealt with industrial accidents has been struck by the altered attitude and psychology of a large proportion of those injured.

For obvious reasons, then, the quantitative evaluation of a subjective symptom such as pain, occurring under such conditions, and the attempt to determine the degree of disability resulting therefrom, is fraught with the greatest difficulties. Pain, tenderness, stiffness and muscle spasm are the four cardinal signs of back injury and their absence means the absence of actual disease. When the pain is real it is always accompanied by one and, when severe, usually by all of the other manifestations. Of these, involuntary muscle spasm is the most definite and easily demonstrated. By it is meant an involuntary tonic contraction which can be felt and frequently seen. It is reflex, constant, uniform and independent of the patient's attention. It represents nature's attempt to splint the joint and prevent harm. Unilateral muscular rigidity can not be feigned. Voluntary rigidity on the other hand is always bilateral, is not uniform but jerky during movement, and lessens or disappears when the patient's attention is distracted. Tenderness and anaesthesias which are diffuse and fail to recognize anatomical limitations are also neurasthenic or counterfeit.

A detailed history of the original accident and subsequent condition is of the greatest importance. This can then be checked with the original record and that of subsequent statements. Frequently wide discrepancies will be found. One man originally claimed a strain from lifting a fifty pound chunk of coal; six months later the size of the chunk had increased to 300 pounds! Another claimed a severe contusion of the back which rendered him practically unconscious for several hours, but whose original record showed an isolated injury to the leg with no complaint of any back symptoms during the time his leg was being treated.

In real disabilities the symptoms and signs are constant and associated with each other in a consistent and determined manner. In such cases the patients complain of the same pain, show the same tender points and give the same reactions to motion each time they are examined. Much can also be told of their real condition by carefully watching them unlacing and lacing their shoes and withdrawing their undershirts, particularly if they think they are unobserved. The detection of exaggeration and malingering, however, rests upon a most careful and complete examination and the elicitation of gross inconsistencies, such as wide variations in points of tenderness, impossible and varying sensory changes, the normal free use of muscle groups without evidence of distress when the significance of the test is not recognized, and the notation of variables at subsequent examinations. Unfortunately, the valuable information that could be obtained from casual and unsuspected observation at home or elsewhere is unavailable.

Thirty-five cases, or four per cent., were considered to be malingerers, these conclusions being based upon the principles outlined above. Cases of simple exaggeration where the men had received real injuries and were only slightly reluctant or dilatory about returning to work are not included. Three cases were originally classified as deforming arthritis, but as they claimed absolute inability to perform even the lightest chores after months and months of idleness and subsequently resumed their previous occupations within a week of the settlement or rejection of their claims, it seemed more rational to place them in this category. Four of the cases were originally classified as probable neuroses, but as they too returned to work within a few days of the termination of their suits it seemed that their complaints must have been counterfeit. Four of the men received their alleged injury only a few days before a general strike and six were hurt the day their mines closed. One frankly admitted malingering while in the army, first to escape service at the front and later to obtain an early discharge. One reported his injury the day after he was discharged and two men worked one and five months respectively after their injury and developed their disability only when discharged for other causes. One was thought to have a real injury, received a large cash settlement, and returned to work at once. One old man was paid more as compensation than he received as wages.

While the number of cases is not great, it is believed that it represents

a higher percentage than occurs in other classes of injuries with the possible exception of traumas to the head. This is probably due to the well known impression in the minds of working men that it is only necessary to complain of pain in the back to gain sympathy, and that it is impossible to detect malingering in this particular type of injury. It must also be borne in mind that a general knowledge of the symptoms of such a disability has become current coin in every hazardous industry.

TABLE 7

SIMPLE EXAGGERATION

	No. of cases	*Cases showing exaggeration*	*Per cent.*
Sprain	498	51	10
Contusion	122	26	21
Fractured vertebral processes	40	3	7
Fractured vertebral bodies	30	4	13
Chronic arthritis	107	27	25
Total	797	111	14

In Table 7 an attempt has been made to list the cases showing what, for want of a better term, has been called simple exaggeration. It includes those cases which were either obviously reluctant or dilatory about returning to work or who claimed total disability when it seemed evident that there were many forms of light manual labor which they could perform comfortably and efficiently. An attitude of fairness has probably kept the percentage much lower than the actual facts. In addition a large majority of the men belong to lodges and other organizations whose benefits become material if their disability is prolonged beyond a few weeks.

DISEASE

In ninety-seven cases, or ten per cent., the condition of the back or the symptoms complained of seemed definitely attributable to disease and not to accident. The diagnosis in this group is shown in Table 8.

Few of these require comment. Of the twenty-seven cases of lumbar myositis thirteen were acute and fourteen chronic. The acute cases all gave a history of a more or less recent acute infection of some sort with the subsequent development of more or less acute backache during or after a day's work. The chronic cases all gave a history of previous lame back with frequent identical attacks unrelated to employment and did not describe anything that could be interpreted as an accident. These cases emphasize again the importance of an early, carefully taken history. The twelve cases of fatigue simply got tired and had backache while at work; six occurred in old men who had obviously outlived their period of efficiency as manual laborers, three of whom had hypertensive arteriosclerosis

with albuminuria; two occurred in well developed cases of diabetes; two in men soft and unaccustomed to manual labor; one was a chronic alcoholic and one a constitutional inferior. It has seemed remarkable how the natural selective process has eliminated most men with actually weak backs, except those who may be said to have grown old in the service. Of the twelve cases of syphilis seven had tabes, two with Charcot spines and two with renal crisis, three had aortitis with typical anginal attacks with the pain located between the shoulders; one had cerebrospinal syphilis and one a gumma of the twelfth dorsal vertebra.

TABLE 8

DIAGNOSES IN BACK CONDITIONS NOT DUE TO INJURY

Myositis	27
Fatigue	12
Syphilis	12
Acute upper respiratory infections	8
Renal calculi	6
Gonorrhea	5
Acute rheumatic polyarthritis	3
Urethral stricture with cystitis	3
Acute nephritis	3
Pulmonary tuberculosis	2
Hematuria—cause undetermined	2
Hypertrophied prostate with cystitis	2
Cancer of prostate	2
Hydronephrosis	1
Pyonephrosis	1
Poliomyelitis	1
Cord tumor	1
Colitis	1
Cholecystitis	1
Peptic ulcer	1
Tuberculosis spine	1
Infected sebaceous cyst	1
Auricular fibrillation	1

ANOMALIES OF THE SPINE

Variations in the spine from the normal or text book anatomy are very common. Familiarity with them is necessary not only to avoid errors in interpreting x-rays but also because of their possible relationship to the persistence of symptoms and disability following injury. Such anomalies may be of number, shape, development or position.

Of the 941 cases comprising this study, 491 were x-rayed; of these the pictures in 402 cases were available for restudy. The cervical and cervicodorsal regions were shown in thirty-seven cases and showed no anomalies. The dorsal and dorsolumbar regions were shown in 227 cases

and in these were eleven variations, or four and eight-tenths per cent., all limited to the dorsolumbar junction. Of these, three showed rudimentary twelfth ribs of such a degree as to closely resemble the adjacent lumbar transverse processes; seven showed failure of union of the transverse processes of the first lumbar vertebra, five bilateral and two unilateral; and one apparently well developed lumbar ribs. In 341 cases showing the lumbar and lumbosacral region there were fifty-five variations, or sixteen per cent. Some of these were combined so that there was an actual case percentage of twelve and three-tenths per cent. The most common anomaly was failure of union of the posterior processes of the first sacral vertebra which occurred thirty-five times. In thirty the defect was slight, resulting in a simple split spinous process. In five it was more marked and in two cases accompanied by a similar defect in the fifth lumbar vertebra with the production of a distinct spina bifida. There were six cases of sacralization of the fifth lumbar vertebra, four asymmetrical and two symmetrical. There were five cases of abnormalities in the transverse processes of the fifth lumbar vertebra, the most common being large, wing-shaped, irregularly pointed affairs usually somewhat asymmetrical. In only one could impingement on the adjacent ilium be satisfactorily demonstrated. Six lumbar vertebrae were found three times, and in one case there were apparently only four, though as the whole spine was not taken it was impossible to be positive. There were two cases of spondylolisthesis, both resulting from heavy falls of coal upon the lower back, and without definite evidence of distinct developmental defect, but placed in this group for convenience. There was one case of anomalous development of the fourth lumbar vertebra.

TABLE 9

CONGENITAL ANOMALIES

	Total	*No. of anomalies*	*Per cent.*
Cervical and cervicodorsal region	37	0	0
Dorsal and dorsolumbar region	227	11	4.8
Rudimentary twelfth ribs		3	1.3
Non-union transverse process first lumbar		7	3.0
Thirteenth rib attached to first lumbar		1	0.5
Lumbar and lumbosacral region	341	55	12.3
Split spinous process first sacral		35	10.2
Split spinous process fifth lumbar		2	0.6
Sacralization fifth lumbar vertebra		6	1.7
Asymmetrical 4			
Symmetrical 2			
Abnormal transverse process fifth lumbar		5	1.5
With impingement on ilium 1			
Numerical variations		4	1.1
Six lumbar vertebra 3			
Four lumbar vertebra (?) 1			
Spondylolisthesis		2	0.6
Asymmetrical fourth lumbar vertebra		1	0.3

(The apparent discrepancy in the number of cases is due to the fact that more than one region was often x-rayed in the same patient. In the lumbar and lumbosacral region thirteen cases presented combinations of anomalies.)

There still exists considerable difference of opinion as to whether the symptoms associated with these abnormalities are really due to their presence, more or less influenced by it, or whether they are merely coincident. While we know that such defects may exist throughout life without producing symptoms, we also know that they are much more frequent in lame backs than in good ones. For example, in 850 museum specimens Willis found split spinous processes in only one and two-tenths per cent., while in one hundred backaches the same abnormality occurred in ten per cent., practically the same figure found in this series. It is also an established fact that a joint is made increasingly unstable by anything that is unequal or abnormal in its development, creating abnormal or asymmetrical motion. Furthermore, the stability of the spine is dependent upon its ligamentous strictures, and bony abnormalities may either weaken these attachments or, by lessening the bony support, throw increased strain upon them. In short, in spines which present anomalies, the ligaments have to do the work the bones are supposed to do and as a result are predisposed to mechanical derangements, the symptoms of which are essentially ligamentous in origin. Naturally the clinical importance of these abnormalities varies considerably. Numerical variations are of no importance except that abnormally long spines are more susceptible to sprain from strain or torsion and abnormally short ones less flexible. Likewise, cervical ribs and variations in the size and development of the ribs and transverse processes in the dorsolumbar region are of little practical significance in industrial cases except from the standpoint of diagnosis. Asymmetrical sacralization exposes the parts to abnormal leverage and consequent ligamentous injury. Complete sacralization on the other hand can have no effect other than shortening the mobile portion of the spine. In impingement or articulation of the transverse processes of the last lumbar vertebra with the ilia the symptoms seem to be due to strain of the sacrosciatic and sacrolumbar ligaments from the leverage of the process against the ilium or to the stretching of the adjacent nerves. The tendency at present is to disregard the theories of pressure on other soft parts and irritation of a possible bursa interposed between the process and the ilium. Defects in the posterior portions of the neural arch, varying from a simple split or bifid spinous process to a more or less well marked spina bifida, are of significance in two ways. First, these defects interfere with the adjacent ligamentous attachments which are thus rendered inherently weak, the degree, of course, varying with the degree of the defect. Secondly, such defects in the bony portions are united by fibrocartilaginous areas and these are prone to forcible separation under strain. Once separated they show little if any tendency to unite, the disability persisting as evidenced by chronic ligamentous and nerve irritation.

An attempt at a statistical study of the cases found proved unprofitable, as their distribution in the various groups was too general and definite knowledge of the outcome of the individual cases too scant. The impression gained, however, was that they were not of much importance. Bilaterally separated neural arches are perhaps the most serious defects. In these cases there are usually accompanying defects in the inferior articular processes so that the anchorage of the spine upon the sacrum depends entirely upon a fibrocartilaginous union and ligamentous support. When this union is once ruptured the lumbar spine coasts downward over the oblique superior surface of the sacrum resulting in a spondylolisthesis and permanent loss of stability. A very similar and perhaps more common condition is present in those cases showing an abnormal lumbosacral angle due either to the fifth lumbar vertebra being set too far forward or at too great an angle, or to an increased obliquity of the sacrum. In such cases there is less bony support at the lumbosacral junction and increased dependence on the adjacent ligaments, which, while strong, are often not strong enough to withstand the enormous twisting or shearing leverage to which this part is subjected. Failure of this ligamentous support leads again to spondylolisthesis. Minor grades of this and kindred disorders are probably more frequent and important than is generally recognized, but too few of the pictures in this series were sufficiently clear or properly taken to permit of its evaluation.

Great as is the difference of opinion concerning the significance of these developmental abnormalities there is still greater difference of opinion as to their treatment. Such patients recover both with and without operation and the matter is still open for discussion. Operations are often difficult and are not without danger. On the other hand, it seems more rational to direct treatment toward overcoming the exciting factor of ligamentous strain rather than in attempting to remove the merely contributing factor of developmental defect.

COMMENT

The first essential in the study of back injuries is an accurate history. The importance of this has been emphasized by all recent writers on back pain and can not be stressed too much. It should consider: first, previous accidents, pains, aches and lameness in the back. This data should be obtained early as it is often impossible to elicit it later. Second, it should contain a detailed account of the injury in question; that is, whether it was due to direct or indirect violence, a blow, a fall, a lifting strain or twist, and if so what the position of the individual was at the time. The mechanical etiology, when fully understood, has a very direct bearing on the diagnosis and is a great aid in forming an estimate of the resulting disability. For instance, there are two general types of sprain. The first is the result of severe muscular exertion, the force being exerted by the man himself. This form usually results in pure muscular or musculoligamentous strain, perhaps with a definite muscular tear or a loosening of the

fascial attachments of the big muscles of the back. The second form is due to external mechanical violence in which the strain is exerted independent of the patient. This occurs most frequently when sudden strains from heavy objects appear unexpectedly, as when several men are carrying a heavy load and one or more of them let go their hold without warning, thus suddenly shifting the whole load on one or more of the group. This type is more often ligamentous and severe, as the muscles are not in, and do not have time to be put in, full protective action, and the men are usually bent slightly forward in a position of physical disadvantage.

The second essential is thorough, careful examination directed not only to determine the nature and extent of the injury but also the exact status of the individual's condition and health. The most essential thing is whether the injury occurs to a normal back or to one the seat of some pathological process or structural abnormality. The need for an accurate diagnosis in those cases with persistent symptoms is acute, and the feeling seems to be growing that most of these cases are due to more than one cause—a strain superimposed upon a previously symptomless arthritis, static abnormality or anatomic variation. In other obscure cases the search for remote causes is of equal if not greater importance than that for those of local character. Distant disease and foci of infection are often the chief factors in keeping active a focus of irritability originally induced by trauma. Many cases of sprain follow minor exertions without slip, twist or sudden wrench, that hardly warrant the term accident. There is no doubt that muscular and ligamentous tone increases and decreases with the general health of the individual and with it the susceptibility to strain or sprain. May we not then ask how many of these were not accident at all, but disease as represented under that vague term "crick"? Nearly every one has experienced these sharp catches after minor exertions such as stooping, raising a window, moving a chair, etc., with subsequent discomfort or disability for several days or weeks. Such conditions undoubtedly represent localized areas of inflammation or irritability developing as a result of distant disease. If this pain develops during work or shortly afterwards, as it almost must, it is only natural that the affected individual should seek its explanation in that work. Such allegations are genuinely conceived but are based on erroneous ideas of etiology which are characteristic of the lay mind regarding not only backache but a host of other human ills.

The third essential is adequate treatment. This should be carried out along the lines of ordinary scientific medicine and not by haphazard and usually futile plans which are applied irrespective of the probable pathological lesion present, and without any consideration as to whether the subjective symptoms are due to real injury to the back itself, to the neighboring viscera or to diseases which have nothing to do with the alleged injury. It consists essentially in rest, support, heat, massage and graduated use. The most common causes of unsatisfactory progress are failure to report the accident early, to control the patient and to persistently

follow up the treatment instituted. Rest and support seem to be the two most neglected factors. Rest is most efficacious early and to accomplish anything must be complete and in recumbency. Support when necessary should be real support and should be continued long enough. Adhesive straps applied to a movable skin are seldom adequate. The good results achieved by intensive treatment of the severer injuries to the spine, such as compression fracture, indicate what similar methods would do when applied to lesser injuries. Men with backs weakened from either injury or disease should be taught to lift with their thighs and not with their backs. While many cases receive very inadequate attention, the tendency to overtreatment must also be guarded against. Quite frequently cases of relatively minor injury, which have been properly treated and where the disability should be a matter of weeks or at most of a few months, return for examination and treatment after many months, the men still complaining of disability due to pain, without having made a persistent effort to work.

The peculiar mental attitude developing in so many of these cases adds very materially to the difficulty of making an accurate diagnosis and definitely delays recovery. In such cases it often takes but a short time for the persistent sensitive mental representation to become indistinguishable from a real sensation. Once such an association is fixed by fear, dread, dissatisfaction or desire for compensation it is most difficult to remove until all claims are settled. However, a little direct personal interest by the attending physician with an explanation of the nature of the injury, the aims and methods of treatment, and the expected period of inactivity will often prevent a prolonged disability. From an industrial and sociological standpoint, cases of delayed convalescence in employees are particularly unfortunate. The insurance company and employer are apt to feel that the laborer is malingering, while the injured man himself is convinced that he has been given inadequate attention and unfair treatment. When he at last returns to work, it is in an antagonistic and resentful frame of mind. The physician's first duty is to his patient and any complication which delays or prevents complete recovery should be guarded against even though purely functional or neurotic in character.

SUMMARY

A study was made of 941 consecutive cases of back injuries in industrial employees.

Sprain occurred in 498 cases, or fifty-three per cent. The most frequent site was the lumbosacral region where about two-thirds of the cases were located. In about eleven per cent. the condition seemed to be sufficiently localized about the region of the sacro-iliac joint to warrant the term sacro-iliac sprain. This was regarded simply as a neighborhood injury and not as a specific entity. The next most frequent site was the mid and upper lumbar region, where about a fourth of the cases occurred.

The dorsal region is relatively fixed and is very infrequently subject to sprain, while the cervical region is protected by its position. In about half of the cases the lesion seemed to be unilateral or at least predominatingly so. In the other half the lesion was located centrally. The average period of disability in 310 cases where it was known was five weeks. This showed a steady increase from one week in dorsal lesions to eleven weeks in sacro-iliac lesions. There was also a progressive increase in the period of disability according to the age of the patient. Static abnormalities occurred in twenty-one cases and distinctly increased the period of disability.

Contusions occurred in 122 cases, or thirteen per cent. The average period of disability in the seventy-nine cases in which it was known was about seven weeks.

Fracture of the vertebral processes occurred in forty-one cases or four per cent. In thirty-six cases the fracture involved one or more of the transverse processes. In about half of these the fracture was due to abnormal muscular pull and in about half to direct violence. In about a third the fracture was single and in about two-thirds more than one process was involved. Of the individual vertebrae the processes of the third were most frequently involved; those of the others in decreasing frequency above and below. In those cases due to the indirect violence of muscular pull almost all the fragments were widely displaced. In the cases due to direct violence, few showed more than appreciable displacement. Cases without much displacement showed evidence of callous formation and union in one to three months. In sixteen cases where the period of disability was known it averaged twenty-four weeks. There were two cases each of fracture of the spinous processes and neural arches, and one case of involvement of an articular facet.

Fracture of the vertebral bodies occurred in thirty cases, or three per cent. Many of these followed what seemed to be slight accidents and were surprisingly devoid of symptoms. Two-thirds gave no history or showed no evidence of cord involvement. In eighty per cent. the force causing the fracture was applied indirectly, the majority of the men being struck on the back while in the stooped position. About a third of the cases showed a distinct posterior kyphos or knuckle. The prognosis in these cases, of course, varied with the extent of the injury. Eleven cases, or a little over a third, were known to have returned to some form of active labor in the mines. In ten of these the period of disability was known and averaged thirty-four weeks.

Chronic deforming arthritis was found in 107 cases, or eleven per cent. This is regarded primarily as a chronic infectious disease. Spines so involved are damaged structures permitting of motion only through limited arcs. Slight injuries seem capable of increasing the local activity of the process, while motion forced beyond the limited arc may result in serious consequences. Most of the cases so classified showed gross foci of infection, about half showed well marked arteriosclerosis, and about a

sixth static abnormalities of the feet and legs. Two-thirds of the cases studied early in the course of their disability gave a more or less definite history of chronic lame back. This was absent in practically all of those seen after an interval of more than a few weeks, so that it occurred in only ten per cent. of the whole group. In nearly a fourth of the cases, there was a definite history of progression. In fifty-two or about half of the cases the period of disability was known and averaged fifteen weeks.

A neurosis was diagnosed in eleven cases, or one per cent. The fundamental condition here is a disorder in conduct occurring in individuals who are fearful, dissatisfied, and who seek compensation. Their condition results not so much from the accident as from the erroneous opinion they have formed of the nature and extent of that accident and of the rights to which they are entitled. They are probably all inherently neurotic. This diagnosis can only be made by exclusion. The greatest difficulty comes in differentiating a true neurosis from malingering. Unless there is sufficient evidence to definitely answer this question, it is safest to maintain a purely objective viewpoint and merely determine the extent to which the patient is dominated or disabled by his neurosis.

Malingering occurred in thirty-five cases, or four per cent. It was believed that fourteen per cent. of the entire group showed more or less marked exaggeration at some time during their observation.

In ninety-seven cases, or ten per cent., the condition of the back and the symptoms complained of seemed entirely attributable to disease.

Variations in the spine from the normal or text book anatomy occurred in four and eight-tenths per cent. of the cases in the dorsolumbar region and in twelve and three-tenths per cent. of the cases in the lumbosacral region. The most common anomalies were split spinous processes, usually of the first sacral vertebra, and sacralization of the fifth lumbar vertebra. The importance of these anomalies is their tendency to weaken the mechanical construction of the back, thus predisposing it to injury and delaying its recovery after injury.

CONCLUSIONS

Back injuries are essentially similar to those occurring to any other jointed structure and taken as a group give an equally promising outlook. The frequent severity of the resulting symptoms is due to the complexity of the structures involved and the difficulty of obtaining and maintaining immobilization.

In industrial cases the most frequent causes of unsatisfactory progress are failure to report the injury early, to make a complete examination and diagnosis at once, to prescribe efficient treatment and to persistently follow up this treatment.

About fourteen per cent. of the cases show an altered attitude and psychology which makes both diagnosis and prognosis difficult. Much of this could be eliminated if the attending physician would take the trouble

to establish a more personal contact with his patient and explain his condition to him.

While many patients are undoubtedly inadequately treated, there is almost as great a tendency to overtreat individuals who refuse to make an honest and persistent effort to return to work.

The writer wishes to acknowledge his indebtedness to Dr. Charles L. Patton for his guidance in the preparation of this paper as well as for his kindness in placing some of the material at his disposal.

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THE RESULTS OF THE DAVIS METHOD OF REDUCTION OF CONGENITAL HIP DISLOCATION*

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In the past ten years the treatment of congenital dislocation of the hips has been constantly brought to the attention of orthopaedic surgeons. Numerous articles have been written describing various methods of reduction and after-care. The value of manipulation and open operation has been discussed, but in all these papers practically no changes in what might be called the basic principles of treatment have been made. It was from the desire to check up on these principles, especially from the view-point of teaching in the Post Graduate Department of the University of Pennsylvania, that a survey of our cases of congenital dislocation was made. This survey has convinced us that our treatment is still far from perfect and this paper is presented with the hope that our mistakes and our endeavors to correct these mistakes may lead to greater improvement in treatment. As a basis for this discussion the survey of the cases reduced five years ago—that is, during the latter part of 1920 and the early part of 1921—is presented. These cases give a brief example of our results and they, together with our later cases, form the basis of our conclusions. It is impossible to go into the many details of treatment and only a few important phases are presented.

The Davis method of reduction is well known and does not need further description. The cases reported in brief were all done by this method by various members of the staff of the Graduate School. They total twenty cases, of which six showed double dislocation, making twenty-six dislocations in all. In this series, nineteen cases were girls. The earliest operation was done at fourteen months of age, and the oldest at eight years. Two cases (10%) were total failures by this method. These cases were both double dislocations, so that four (15%) out of the twenty-six reductions failed. Six cases (30%) showed reduction with instability of the hip joints. This class includes the other four cases of double dislocations, making ten reductions. Twelve cases (60%), all single dislocations, gave good functional results.

Of the two failures, one case has refused further treatment and one case has been reduced recently by open operation.

The six cases classed as "reduced but unstable" offer the most interesting problems of the series. In all these cases the reduction was difficult, and a considerable amount of force was necessary to obtain results. In three of the cases the primary reductions were failures and the dislocations

*Read before the American Orthopaedic Association at Atlanta, April 27, 1926.

were only reduced by manipulation after a period of heavy traction. In all the cases the after-treatment consisted of the usual plaster-of-Paris fixation at about ninety degrees abduction. The cast was changed and the amount of abduction lessened within five to eight weeks, and all the cases were walking, in cast, with abduction of fifteen degrees or less within nine months. The x-rays *before* reduction show the usual misplaced femoral head and shallow socket with little or no deformity of the femoral neck and head. The x-rays *after* reduction show a considerable deformity of the head and neck of the femur. The head is shown by examination and by stereoscopic x-ray to be well forward and in the socket. The acetabula are shallow and of abnormal length. The widening is always in the upward direction and at times the socket has over twice the diameter of the normal case. The upper rim is deficient, giving very poor support to the femoral head which lies in the upper part of this socket. This deformation begins shortly after the reduction, showing in one case within three months after the manipulation. In this case, at the time of x-ray, the leg had been brought down to an angle of forty-five degrees from the long axis of the body. In other cases the upward spreading occurred within the first year and does not seem to have increased since that time. In fact, in some cases the upper margin seems to have become thicker and deeper during the subsequent weight-bearing.

Functionally, these cases all show some degree of limp with weak gluteal power, slight limitation of abduction and shortening of one-quarter to three-quarters inches in the unilateral cases. The parents of all these children report that they have markedly improved in their gait, are able to carry out their school activities, and suffer no pain nor discomfort. They also refuse any further treatment aimed at stabilization, stating they are satisfied with the present results. This improvement in function is undoubtedly due to the reduction of the posterior displacement of the femoral head, and the correction of the weight-bearing alignment that this brings about.

Unquestionably the changes of the socket and of the head of the femur are due in large part to the trauma at the time of reduction and to too early weight-bearing on the defective joint. In our later cases we have endeavored to be more gentle in our manipulations, and have kept the hips in full ninety degrees abduction for a much longer period. Certainly we are now having a much smaller percentage of unstable hips. Although this type of case cannot be considered as a functional cure, it is certainly a great improvement over the dislocated position.

It is very interesting, however, to speculate on the ultimate result in these unstable cases. We count them now as improved, but the question must arise as to whether this improvement will continue until and during adult life. The present good function of these joints depends mainly on the strong muscular supports, and not on the bony structure, and I am afraid that in adult life when weight-bearing increases and muscular tone diminishes, these joints will again become more or less disabled. This

opinion is strengthened by the study of several young adults who had congenital dislocations reduced in early childhood by very vigorous manipulation and who are now complaining of painful weak joints following illnesses that have caused moderate loss of muscle tone. These show by x-ray the same type of deformed femoral head and shallow socket as is seen in our cases of unstable hips. With this possibility in view it seems rational to advise the patients extra-articular operative procedures to increase the supporting shelf at the upper acetabular edge, the upward displacement being of minor importance.

The cases which have been listed as good functional results offer other interesting problems. In these cases the resultant shortening has been one-half inch or less. The gait is stable. The gluteal muscles act well. All motions of the hip joints are painless and show very slight or no limitation of motion. The x-rays, however, show a surprising amount of deformity of the head and neck of the femora. In these cases the acetabula before operation were very similar to those observed in other cases of the series, but they have developed more normally, and now show very firm upper supporting rims. As has been said the amount of deformity of the head and socket is in direct proportion to the amount of trauma at the time of manipulation. In other words, the more gentle the manipulation,

FIG. 1. CASE 1

FIG. 2. CASE 1

B. K. Reduced five years ago at age of seven. Reduction very difficult. Present function normal.

the smaller seem to be the dangers of bony defects. This point has been strongly emphasized in our cases and it has also been obvious that the earlier the case is brought to treatment, the easier is the reduction. In the few cases that have been treated before eighteen months of age, the functional results are excellent, and the x-ray pictures are far superior to those of the older cases. It, therefore, seems to us that we are not justified in delaying treatment until the second year or later. It seems more logical to operate on these cases at the earliest possible moment, preferably before the weight-bearing begins. At the present time nearly all the text books advocate reduction after two years of age on account of the difficulty in keeping the skin under the cast clean and healthy. These difficulties can be overcome by well applied casts or braces, careful nursing and the placing of the child on inclined Bradford frames. Certainly the advantages of reduction before weight-bearing, when the soft parts have not become thickened or stretched and when the acetabulum is more able to resume its normal relationship to the femoral head, more than make up for the difficulties of after-care. These are not new ideas, but they have not been sufficiently emphasized and we believe that orthopaedic surgeons should educate themselves and the profession at large to the need of early diagnosis and immediate treatment. As a corollary to this idea, it also

FIG. 3. CASE 2

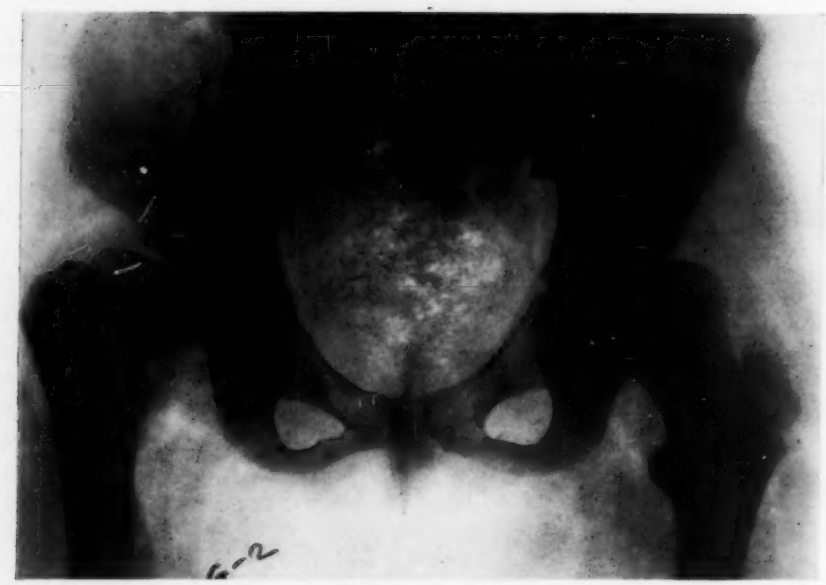

FIG. 4. CASE 2

A. D. Difficult reduction in 1921 at age of three. Function of hip now normal in spite of deformity of femoral head.

FIG. 5. CASE 3

FIG. 6. CASE 3

E. McE. Reduced six years ago at age of two. Reduction easy. Slight deformity of head with normal function.

seems logical to advocate open operation when gentle manipulation fails. However, manipulation is so simple and so effective, especially when done in the pre-weight-bearing stage, that we do not believe that we are justified in submitting the patient to the increased dangers of open operation until manipulation has been tried.

The true value of end results of any given operation does not lie in an elaborate mass of figures and percentages. It really lies in the finding out of mistakes made and the correction of these mistakes in future treatment. Therefore, there is presented to you for discussion the four chief principles of our treatment of congenital hip dislocation that are the true end results of our survey of the Davis method.

First: That the treatment of this condition should be done at the time indicated for most congenital deformities,—that is, in the period before weight-bearing begins. In this period manipulation is undoubtedly easier, traumatism is less, and the ultimate function of the joint is better assured.

Second: That manipulation in this period is the method of choice.

Third: That the manipulation must be most gently and most skillfully performed. The method of manipulation is entirely a question of personal choice. It does not matter in the least whether the operators use the

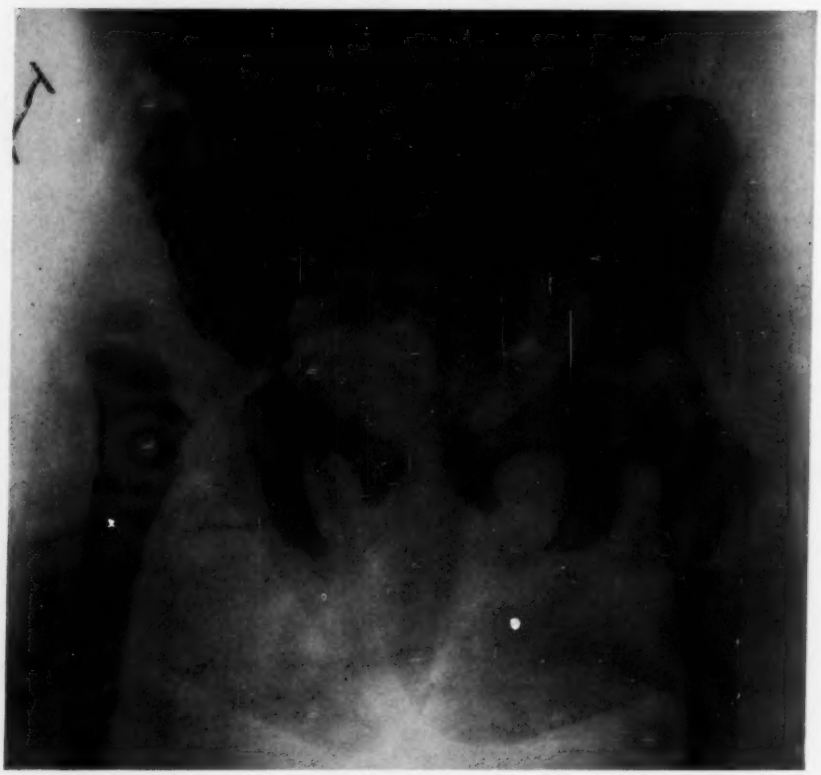

FIG. 7. CASE 4

FIG. 8. CASE 4

S. H. Reduced easily five years ago at eighteen months of age. No deformity of femoral head. Function normal.

Pachi, the Ridlon, the Denucé, the Davis, or any of a dozen well recognized techniques, but it does matter most tremendously whether the operator is skilled in the performance of his method, whether he has the knowledge of just what occurs in the hip region during each step of the manipulation and whether he can apply the minimum amount of force to produce the required result.

Fourth: That reduction by open operation has become an essential part of the treatment of congenital dislocation, but should be employed only when the gentle manipulation has been attempted and has failed, and that at operation not only must the femoral head be placed in the socket, but also an adequate weight-bearing socket must be insured.

A PRELIMINARY STUDY BEARING ON THE SPECIFIC CAUSATIVE FACTORS OF MULTIPLE INFECTIVE ARTHRITIS*

BY L. G. HADJOPOULOS, M.D., AND REGINALD BURBANK, M.D., NEW YORK

In a previous article we demonstrated the presence of specific immune bodies in the blood of arthritic patients and their detection by means of the active serum complement fixation reaction. Although the antibodies worked with covered a wide field they could be reduced to three major groups which in the order of frequency and intensity of reaction were:

1 Against streptococci, various types
2 Against staphylococcus aureus
3 Against the paracolon group of gram negative bacilli.

Excluding certain specific arthritides such as the gonorrheal, luetic, and tubercular joints, practically all other arthritic conditions of unknown or doubtful etiology could be classified in three major groups according to their serological reactions.

1 Those giving fixation with haemolytic streptococci
   (a) exudative, periarticular, myalgic, etc.
   (b) aniso-atrophic deforming arthritis
2 Those giving fixation with viridans streptococci—productive, hypertrophic, osteo-arthritic
3 Those giving fixation with both viridans and haemolytic streptococci—mixed types with both exudative and productive changes present.

As the presence of an immune body presupposes the existence of the homologous antigen somewhere in the system, we undertook an extensive study of the bacteriology of focal infections. In order of their frequency in infective arthritis the following foci seemed to be definitely pathogenic:

1 The throat (tonsils, pillars, pharynx, soft palate, tongue, bronchi, etc.).
2 The teeth (apical abscesses, pyorrhoea, gingivitis)
3 The intestinal tract, including gallbladder, appendix, etc.
4 The nasal mucosa including the sinuses and antra
5 The genito-urinary tract (prostate, vesicles, bladder, kidney, tubes, cervix, etc.).

The bacteria isolated from the foci mentioned in the order of their frequency and pathogenicity, were as follows:

1 The streptococcus haemolyticus (tonsils, pharynx, teeth, fissured tongue, gastro-intestinal and genito-urinary tracts, bronchi)

*From the Pathological Laboratories of Beth Israel Hospital, New York, and Laboratory, 6 East 78th Street, New York.

2 Streptococcus viridans (teeth, tonsils, nasopharynx, intestinal tract, sinuses, genito-urinary tract)

3 Staphylococcus aureus (nasal mucosa, sinuses, genito-urinary tract especially prostate and cervix, and occasionally the gastro-intestinal tract)

4 Colon bacilli, the paracolon group in general (intestinal and genito-urinary tracts, and pharynx, in ulcerative conditions and pulmonary abscesses).

The types of streptococci represented in cultures from the above foci were of great variety.

1 Haemolytic streptococci

Equi, pyogenes, delta (slow-haemolyzing), infrequens (met only once), and other atypical forms.

2 Viridans streptococci

Fecalis, salivarius, mitis, ignavus, alpha prime (partial haemolytic with greenish pigment)

3 Non-haemolytic streptococci

Various types.

With the aim of producing arthritic changes experimentally in animals a series of rabbits were injected with individual strains representing the majority of the streptococci mentioned above. The haemolytic strains were for the most part pathogenic to these animals. Large doses proved fatal and gave septicaemia; small doses, however, gradually developed enough immunity in the animals to allow the giving of ordinarily fatal dosage without killing the recipient. Some of these animals showed joint changes with swelling and tenderness more closely resembling pus formation than we ordinarily find in the arthritic joints in the human.* Further increases in the dosage either proved fatal to the animal or gave no further physical signs of involvement. With the viridans group, using streptococci of the fecalis type, we were able to produce arthritic changes more closely simulating the human type of productive arthritis, but when sectioned and examined the experimental animal type was again more of the pyogenic exudative joint giving a false impression of bony productive change due to the pus and fibrin deposits in the synovial sac.

These results made us feel that there was some food for thought as to the correctness of our theories on arthritis, but both the clinical course of the disease and our serological findings forced us to believe in its bacterial causation, and all evidence at hand pointed to the streptococcus as the offending organism. The next logical step seemed to be to seek the pathogenic organism in the blood stream of the patient as it was reasonable to suppose that if a micro-organism was the causative factor in arthritis, its presence in the blood stream could be detected at some time in the course of the disease. Consequently we made it a practice to take routine blood

*Dr. Lawrence H. Mayers has since improved on this work and has shown more chronic lesions which he describes in an article entitled, "Streptococcus Immunization of Rabbits in Prevention of Streptococcus Arthritis," published in *Surgery, Gynecology and Obstetrics*, pages 176–180, August, 1926.

cultures from all cases examined; but with the exception of very occasional growths of staphylococcus aureus all cultures were negative. This work would have been utterly discouraging had it not been for the fact that blood cultures taken in broth and examined microscopically in the moist stage by means of the hanging-drop method disclosed ill defined streptococcus or diphtheroid-like forms which would not take stains and were not seen in dry smears. In order to determine if these bodies were present in freshly drawn blood we examined freshly citrated blood of arthritic patients in the same way and were convinced that whatever these forms were, they were present in the blood stream itself. Comparing these streptococcus-like forms from the blood of arthritic cases with hanging drops of blood from septicaemia patients where positive growths of streptococci were obtained, we found the pictures so similar as to force us to the conclusion that we were dealing with the same type of bacteria in both.

This stimulated us further to try to grow these elusive cocci. No ordinary culture methods were of the slightest avail, as there was no growth from either aerobic or anaerobic cultures on the most highly nutritive media. We thus came to the conclusion that if we really were dealing with viable streptococci, the failure to grow them must be due to some growth-checking substance or substances circulating freely in the blood stream. We could only speculate on the nature of the growth-inhibiting elements which we felt must be present. It made very little difference whether the action was specific or not, for if a bacteriolytic action existed it presupposed the presence of alexin, the complementary something which is usually considered to be non-specific.

The next step in the work was to neutralize the alexin in the freshly drawn blood of arthritic patients and then make cultures. The results exceeded all expectations for, contrary to previous findings when blood cultures of streptococci were obtained only in generalized septicaemias with time honored septic temperatures, with this complement neutralization pure cultures of streptococci were grown from the blood stream of arthritic patients with normal temperatures, who were going about their daily routine with no other symptoms than their swollen or painful joints.

Table No. 1 gives the positive cultural findings in twenty-nine of a total of one-hundred and forty-five arthritic cases. The total percentage of positive findings was twenty. The streptococcus was isolated in fifteen (10 per cent.), diphtheroids in eight (5.5 per cent.), and staphylococcus aureus in five (3.3 per cent.).

In the case of streptococci the bacteriological evidence seemed to point to the fact that we were dealing with a type of streptococcus (haemolytic or viridans) totally different from that found in the streptococcic septicaemias. This was confirmed on working out their biological characteristics.

Morphologically the growths from the blood stream of arthritic patients are identical with other streptococci though the chains are rather short. Biologically they grow well in ordinary media once they are isolated. They are facultative aerobes. They stain well with ordinary

TABLE NO. 1

BLOOD CULTURE FINDINGS IN 29 OF A TOTAL OF 145 ARTHRITIC CASES

Serial Number	Complementary Titres of Serums	Dates Cultures were Taken	Dates of the Appearance of Growth	Gram Stain (+ Stands for positive)	Description of Micro-organisms Grown		Haemolytic Value	Sugar Fermentations				
								Lactose	Mannite	Salicin	Raffinose	Inulin
2135	.02	10/ 7/26	10/10/26	+	Short chains	Streptococci	Haemolytic	–	–	–	–	–
2136	.02	10/14/26	10/17/26	+	Short bacilli	Diphtheroids	Non-haemolytic	–	–	–	–	–
2140	.02	10/15/26	10/17/26	+	Clumps of cocci	Staphylococcus	Aureus	•	•	•	•	•
2156	.02	10/22/26	10/24/26	+	Clumps of cocci	Staphylococcus	Aureus	•	•	•	•	•
2166	.01	10/22/26	10/24/26	+	Clumps of cocci	Staphylococcus	Aureus	•	•	•	•	•
2194	.01	10/29/26	11/ 9/26	+	Short chains	Streptococci	Viridans	+	+	+	–	–
Mrs. Br's	..	11/ 2/26	11/ 5/26	+	Short chains	Streptococci	Viridans	+	+	+	–	–
2205	.01	11/ 2/26	11/12/26	+	Short chains	Streptococci	Haemolytic	+	+	+	–	–
2206	.01	11/ 2/26	11/ 5/26	+	Short chains	Streptococci	Haemolytic	+	+	+	–	–
2207	.01	11/ 2/26	11/ 5/26	+	Short chains	Streptococci	Haemolytic	+	+	+	–	–
2208	a/c	11/ 2/26	11/ 5/26	+	Short chains	Streptococci	Viridans	+	+	+	–	–
2209	.01	11/ 2/26	11/ 5/26	+	Short chains	Streptococci	Haemolytic and Viridans {H / V	+ / +	+ / +	+ / +	– / –	– / –
2210	.01	11/ 2/26	11/ 4/26	+	Short chains	Streptococci	Viridans	+	+	+	–	–
2213	.01	11/ 4/26	11/ 9/26	+	Short chains	Streptococci	Haemolytic	+	+	+	–	–
2215	.01	11/ 4/26	11/ 9/26	+	Short chains	Streptococci	Haemolytic	+	+	+	–	–
2216	.01	11/ 4/26	11/ 7/26	+	Short chains	Streptococci	Haemolytic	+	+	+	–	–
2222	.01	11/ 8/26	11/16/26	+	Clumps of cocci	Staphylococcus		•	•	•	•	•
2224	.01	11/ 8/26	11/11/26	+	Short chains	Streptococci	Viridans	+	–	+	–	–
2241	.01	11/16/26	11/20/26	–	Short bacilli	Colon Bacilli		•	•	•	•	•
1189	.01	11/19/26	11/24/26	+	Short bacilli	Diphtheroids	Non-haemolytic	–	–	–	–	–
2048	.02	11/22/26	12/ 8/26	+	Short bacilli	Diphtheroids	Non-haemolytic	–	–	–	–	–
2195	.01	11/29/26	12/ 9/26	+	Chains	Streptococci	Non-haemolytic	•	•	•	•	•
2278	.01	11/29/26	12/ 8/26	+	Short chains	Died in transplanting		•	•	•	•	•
2089	.01	12/ 2/26	12/13/26	+	Short bacilli	Diphtheroids	Non-haemolytic	–	–	–	–	–
2294	.02	12/ 6/26	12/11/26	+	Short bacillus-like cocci	Diphtheroids	Non-haemolytic	–	–	–	–	–
2295	.02	12/ 6/26	12/17/26	+	Clumps cocci	Staphylococcus	Aureus	•	•	•	•	•
2315	.01	12/13/26	12/27/26	+	Short bacilli	Diphtheroids	Non-haemolytic	–	–	–	–	–
2327	.01	12/16/26	12/29/26	+	Short bacilli	Diphtheroids	Non-haemolytic	–	–	–	–	–
2363	.01	1/ 5/27	1/ 8/27	+	Diplococci	Streptococci	Doubtful Haem.	+	+	+	–	–

dyes and retain the gram stain. On solid media they grow like other streptococci in very fine pin-point colonies, and on blood plates certain strains give a clear cut haemolytic zone around the pin-point growth while others give a fairly large zone of methaemoglobin discoloration such as is seen around viridans cultures. In differential sugar media both haemolytic and viridans types ferment lactose, mannite, and salicin, but not raffinose and inulin. In accord with Holman's classification the haemolytic strains are akin to the streptococcus infrequens: the viridans to the streptococcus fecalis.

PATHOGENICITY

Rabbits, guinea pigs, and white mice were injected with the above strains; the intravenous route being used for the rabbits, the intraperitoneal for the guinea pigs and mice. Six different strains of haemolytic and six of viridans were used in the experiments.

FIG. 1

Rabbits No. 1 and No. 2. (Photograph taken January 4, 1927.) Note the deformity as indicated by the arrows.

FIG. 2

Rabbits No. 1 and 2. (Photograph taken January 4, 1927.) Note the deformity as indicated by the arrows.

FIG. 3

Rabbit No. 2. (Photograph taken January 4, 1927.) Note how the animal protects the right foot. The radiogram (Fig. 5) of the same foot shows the periarticular infiltration of the soft tissues.

Contrary to previous experience with streptococci, these animals apparently suffered very little from massive injections of these haemolytic and viridans strains. Doses as large as ten billion of freshly grown bacteria were injected at one time but, with the exception of one mouse that died in three days with general signs of septicaemia*, the animals experimented on either did not suffer at all or were sick only for a day or two following the injections. For an interval of one or two months the animals were apparently symptomless.

*On necropsy this animal showed marked congestion of all internal organs, especially the peritoneal lining of the small intestines. There were no focal abscesses in any of the viscera. Cultures of spleen and of blood from the heart were positive for a haemolytic streptococcus with identical sugar fermenting properties as the original strain used.

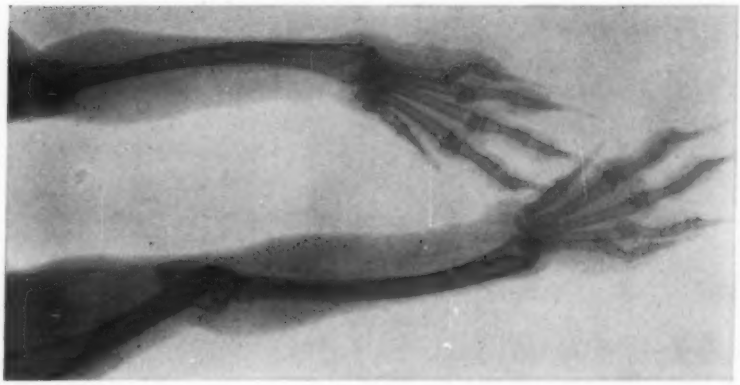

FIG. 4

Rabbit No. 1 (X-ray taken January 4, 1927.) Marked degree of cartilage absorption of carpal bones, both front feet, and periarticular infiltration with marked abduction deformity.

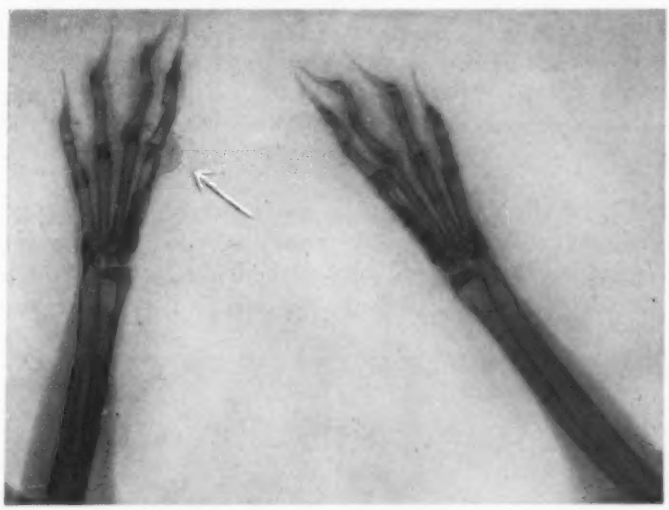

FIG. 5

Rabbit No. 2. (X-ray taken January 4, 1927.) The pathological changes are limited to periarticular infiltration (exudative) at the metacarpophalangeal joint of the second toe.

Then localized symptoms gradually manifested themselves in the joints, first of the front and later of the hind feet, and although no apparent swelling, redness, or local heat was evident at the onset of symptoms, marked tenderness around the joints and pronounced deformity developed. The musculature grew weaker, and certain groups of muscles especially the abductors and internal rotators became tense, giving rise to types of deformity similar to the characteristic aniso-atrophic changes that occur in human beings.

All animals took their food normally and held their weight well. Atmospheric changes distinctly altered the sensitiveness of the joints, and

FIG. 6

Rabbit No. 3. (X-ray taken January 10, 1927.) Moderately advanced destructive changes and beginning aniso-atrophic deformity of both wrists.

cold and humidity produced a pronounced ill effect similar to that seen in the human. In fact, the general course of the disease so closely simulated the human type as to leave little doubt in our minds that the organisms employed were causative factors in the production of arthritis.

With the exception of the one mouse hitherto mentioned as dying with septicaemia, all the animals experimented on are still living. Consequently we have no autopsy records of this series for pathological study. We have, however, taken roentgenograms of the affected animals. Figure 4 shows the front foot of rabbit No. 1; Dr. Gottlieb's x-ray report on it is as follows:

January 5, 1927.
Marked degree of cartilage absorption of the carpal bones, especially of the cartilages on the under surface of the radius. Internal displacement of carpal bones on radius and ulna. Considerable degree of periarticular infiltration of the soft tissues.

Figure 5, rabbit No. 2, shows beginning destructive changes in the carpal cartilages and pronounced periarticular soft tissue infiltration around the metacarpophalangeal joint of the second toe. (See also Figure 3, and note how the animal protects this foot.) Figure 6, rabbit No. 3,

FIG. 7

Rabbit No. 5. Normal control case for comparison.

FIG. 8

Rabbit No. 1. (X-ray taken February 15, 1927.) Compare with Fig. 4 and note the progress of the destructive changes since the date Fig. 4 was taken.

shows moderately advanced destructive changes in cartilages of carpal bones, and beginning aniso-atrophic deformity. Figure 7 is a normal control case for comparison. Figure 8 is the roentgenogram of rabbit No. 1 taken six weeks later to show the progress of the pathological changes already noted in Figure 4. Dr. Gottlieb's x-ray report is as follows:

> February 16, 1927.
> Marked degree of periarticular infiltration of the soft tissues of both wrist joints. Marked degree of absorption of the intracarpal cartilages with a marked degree of radial deviation of the wrist bones.

CONCLUSION

Whether these blood culture strains produce symptoms because of ectotoxins, and if such be the case, the possibility of creating a satisfactory antitoxin to combat these manifestations, are questions which are still being investigated.

Although the present series is not sufficiently large, and the present stage of the work not sufficiently far advanced to permit the deduction of definite conclusions, the submitted experimental data seem to further emphasize the following theories:—First, that the main primary cause of chronic rheumatoid arthritis seems to be a highly selective group of streptococci. Second, that in the symptom complex of chronic rheumatoid arthritis a secondary rôle may be played by diphtheroid bacilli, bacilli of the paracolon group, and staphylococcus aureus.

Some of the diphtheroid bacilli isolated from the blood stream of arthritic patients exhibited such protean properties as to make us wonder if they are not a transition stage between cocci and bacilli.

TUBERCULOUS DIAPHYSIS*

BY HAROLD RAGOLSKY, M.D., MIDDLEBORO, MASS.

The occurrence of an isolated tuberculous diaphysis is rare, and constitutes a surgical curiosity. Literature contains no reference to a similar instance, wherein the bovine type of tubercle bacillus was demonstrated in an adult.

FIG. 1

X-ray showing periosteal thickening of the femur from tubercular infection.

*The case was seen in consultation by Dr. Z. B. Adams, who suggested that it was of sufficient interest to be published.

REPORT OF A CASE

A man, age 45, was admitted to this clinic on August 31, 1926, where he had been employed for ten years as an engineer. He had always been strong, healthy, and a vigorous worker. The only previous illness which he recalls was influenza in 1918. His family history is strongly tuberculous; his mother, a sister, a brother-in-law, and a child all died of pulmonary tuberculosis.

In April 1924, he experienced a dull ache, with frequent sharp pains in the right thigh, which at that time was ascribed to sciatica. The frequency and intensity of this pain became less and less severe, and disappeared in about three months. There were no constitutional symptoms at that time. In March 1926, after a lapse of twenty months, the pain recurred with a much greater intensity. His appetite became poor, he lost weight, and fatigue soon became a prominent feature. During the remission, he felt that he was in perfect health, except that pressure applied over an area corresponding to the mesial aspect of the proximal half of the right femur elicited some tenderness. At no time was joint motion either impaired or painful. In August 1926, after a loss of weight of twenty pounds, he consulted a staff physician. The part was radiographed (Fig. 1) and a definite periosteal reaction was in evidence, characteristic of proliferation of sepsis. Thus a diagnosis of osteomyelitis was made. At operation,—a four-inch incision on the outer side of thigh,—a drop of pus was exuded from beneath the periosteum. Quantities of thin purulent material drained thereafter. Previous to operation and hospitalization, his temperature was not recorded. Six days postoperatively, temperature began to ascend; its maximum was 104 degrees. There were morning remissions and evening exacerbations. This continued for two weeks when an abscess discharged spontaneously from the dependent surface of the affected thigh. Since then his temperature has been practically normal.

Culture of the material obtained at operation showed no growth. Two weeks later, pus from the discharging sinus was cultured and introduced into a guinea pig. The former showed a growth of tubercle bacilli, and the pig died in less than four weeks of a virulent generalized tuberculosis. Bacilli were recovered, and bacteriological evidence proved the organism to be the bovine type of tubercle bacillus.

At the present time, under a regime of sanatorium treatment plus heliotherapy, the patient has gained twenty-four pounds, his wound has healed, and there is no tenderness to pressure at any point.

BILATERAL DEFECT OF FEMORAL HEADS*

BY C. W. PEABODY, A.B., M.D., F.A.C.S., DETROIT

The following peculiar case is herewith reported in a spirit of protest against its possible casual dismissal as congenital coxa vara, and in an effort at more critical analysis from a developmental and etiological angle. Our study of history, physical findings and roentgenograms has seemed to us to lend support to an hypothesis of congenital absence of the upper femoral epiphysis. The findings were distinctly unusual in our experience, and among the eighty thousand patients registered for general physical examination in this clinic since its inception no hip deformity has appeared which bears any resemblance to this case. Several orthopaedic surgeons of wide experience have seen the roentgenograms and expressed the opinion that the characteristics presented were distinctly novel.

In the literature, reports of absence of the femoral heads and necks are quite rare. This subject was discussed in a paper by Ridlon and Thomas presented before the American Orthopaedic Association in June 1912, and published in the November 1912 issue of the *Journal* of the Association. This paper reviewed the literature up to date and found three previously reported cases: one by Robert in 1851, bilateral, one by Anger in 1864, unilateral, and one by Ridlon in 1909, bilateral. These were observed in children and regarded as congenital defects. Several other cases were found reported in which there was an absence of head and neck with additional defect of upper shaft in varying degree, and the authors of the article mentioned above had also seen several instances of the same extensive defect. In their article Ridlon's previously reported case was reviewed, largely because a second observation three years later had shown the same clinical findings but with x-ray faintly suggesting at this late date a head in the acetabulum. Thomas added a case he had first seen in 1911 at age of two. This child had never walked and x-ray indicated absence of femoral heads and necks. This child a year later by x-ray showed a "perfect head and neck on the right side and congenitally dislocated head on the left side". On account of the observation in these two cases the authors entitled this paper "Absence of Bony Femoral Heads and Necks"; and, as both their cases had had extremely severe and generalized rachitic disturbances, advanced the hypothesis that in severe rickets "the cartilaginous head and neck may not show in the bone picture and may be so undeveloped as to evade detection on palpation". It seems of importance that both their cases at clinical examination showed typical findings of congenital dislocation. Their bibliography is included in this paper. The

*From the Orthopaedic Division, Department of Surgery, Henry Ford Hospital, Detroit.

reported cases have all been in children. In a personal communication, Dr. Ridlon, after examining x-ray of the writer's case, was inclined to believe it of congenital origin, but could not recall having seen a similar adult case.

In addition to literature as appears in the references of Ridlon and Thomas, Dr. Albert Freiberg has favored the writer with a reprint of an article contributed to and published in The American Journal of Orthopaedic Surgery, October 1906, entitled "Defect of Both Femoral Heads in a Chondrodystrophic Dwarf". It includes a very careful and thorough analysis of the clinical and roentgenological findings in this fifteen-year-old child. Although, aside from the absence of capital portion of femur, the hip seemed normally developed, the child showed dwarfism and other disproportionate development and Dr. Freiberg was inclined to look upon the hip deformity as related etiologically to the definite manifestations of chondrodystrophia foetalis. It is interesting that the findings on clinical examination of the hips compared closely with ours. He had not found any previously reported instance of this combination.

A careful scrutiny has been made of all accessible titles in the subsequent literature, and the articles have been studied of any suggestive titles. Perrin, in describing a case of extensive arrest of development of the femur, refers to Duhman's theoretical classification of congenital malformations of this bone, which consists of: (1) diminution in development of the upper epiphysis, (2) absence of upper epiphysis, (3) absence of upper epiphysis and diaphysis. Scaduto, on account of complaint of limp, discovered by x-ray in child of five on one side an entire absence of epiphyseal nucleus and of neck of femur, the other side being normal. Nilsonne, in an article available only in abstract, reported two cases which in infancy seemed to have congenital defect of upper femoral epiphysis and later showed a severe coxa vara. He mentioned that the previous literature contained six other cases. Congenital coxa vara from imperfectly developed femoral heads and deformed necks has been of frequent report, but always presenting definite capital nucleus and definable neck. Kidd and others have reported cases in Duhman's class 3 in which the upper epiphysis and part of shaft have been lacking. Stone had a case of congenital absence of lower femoral epiphysis.

From the survey of references that we have made we feel safe in assuming the occurrence of congenital absence of centers of ossification or suppression of epiphyseal development in the upper end of the femur to varying degree, and that this phenomenon, very occasionally, takes the form of a complete failure of development of the upper femoral epiphysis and resulting complete absence of head and neck.

History and Physical Findings: The patient, L. M., No. 36905, is a young woman of twenty-three who registered for the Diagnostic Clinic December 7, 1923, with a complaint of increasing fatigability and lameness in both hips, accompanied by low backache. She was a clerk by occupation, single, American born of Dutch extraction. No history could be obtained of exposure to tuberculosis, or of any family taint or hereditary disorder. She does not recall any mention of deformities in members of her family. Several brothers and sisters developed normally and she does not think they ever presented

any stigmata of rickets. She was said to have been a full term baby with normal spontaneous delivery and although no precise conditions were noticed at that time, she was always considered by her family to have been deformed in hips since birth, which "were placed too high". She had seemed to develop normally in every other way, but was slow in walking as a baby and did not walk unaided till she was three years old. From that time she was described as having a "waddling gait" with much "up-and-down motion of the hips". She rapidly became active and played with other children, but never could entirely keep up with them. No symptoms or conditions were recalled suggesting any acute or chronic inflammatory hip disorder. She cannot remember at any time any severe injury or any period of acute pain or disability referable to hips.

At about the age of ten, she thinks, the up-and-down action in her hips began to decrease and by the age of fifteen had largely disappeared, although the waddle in her gait persisted. From then on she has been increasingly bothered by aching across the small of her back after being on her feet, and thinks her back is getting more and more hollow. This had never reached the point of disability, but she had been forced to give up dancing on account of this. Both standing or walking brought on aching in hips and back. At this time no definite advice or treatment had been given her, although she had consulted several doctors and a few years ago had visited a very large midwestern clinic where some exercises were prescribed.

Her health otherwise had been excellent, save for some increasing nervousness and for transitory aches and pains in other joints of late. Her past history otherwise was quite unimportant.

The young woman received a general physical survey in the Diagnostic Clinic, resulting, save for mild chronic tonsillitis, in unimportant findings; and was referred to this Division for further investigation of her complaint.

The laboratory analysis included negative blood Wassermann test and routine urinalysis.

On superficial physical examination the most striking observation was the gait and posture, which at once suggested unreduced bilateral congenitally dislocated hips. She showed the characteristic low hyperlordosis, prominent buttocks and waddling gait. The Trendelenberg test was positive on both sides and the tips of the trochanters lay posterior and were well above Nelaton's line. On the other hand with each step there was no relative up-and-down motion of the trochanters and the hips seemed stable. Recumbent, the level remained the same and manipulation could produce no change in length of either limb. It was noticed that in this position the lordosis persisted, and on checking by Thomas' sign there was found to be a mechanical limitation of extension in each hip of about thirty-five degrees. Flexion was possible to ninety degrees and adduction to normal range. Abduction was possible only to fifteen or twenty degrees, and rotation was about one-half normal in both directions. These observations were symmetrical on the two sides. Muscular protection was not present, though discomfort was complained of when any of these motions were forced. No sensation of crepitation was perceived, but some tenderness was evinced on deep palpation in both groins. At this stage of the examination we were suprised at finding a hard resistance under the femoral artery in each groin, suggesting the presence of a bony mass filling the acetabulum, though not definitely definable as head or neck of femur. Otherwise, the skeletal system was found normal. The limbs were of equal length and in proportion to the body, there was no varus or valgus deviation at the knees, but there was quite a marked hallux valgus bilateral. The tibiae were straight. There was no abnormal enlargement of the extremities of any of the bones, and thorax and head were free of any stigmata of rachitis. The muscular system was well developed and all the groups around each hip seemed to have normal power.

Explanation of most of the physical findings seems to appear in the x-ray films subsequently obtained:

(1) Hyperlordosis, combined with mechanical limitation of extension in hips; these findings would seem to inevitably devolve from the closely applied position of the

trochanter major behind the dorsum of the widely flaring ilium, mechanically blocking full extension and necessitating the lordosis.

(2) Waddling gait and positive Trendelenberg; the high, close-in position of the trochanters would not only weaken the gluteals by shortening, but also by robbing them of normal leverage. Their high position seems to be partly from absence of femoral neck and partly from the increased length of the bones above the digital fossa.

(3) Absence of hypermobility; the films indicate a fairly stable articulation.

(4) Limitation of abduction, also inevitable from the absence of neck and close-in position of trochanters.

Analysis of Roentgenograms: The following more detailed study of the films may be justified.

While the major deformities occur in the femora, the pelvis shows some distinctly abnormal characteristics. Viewed as a whole it seems to have a transverse dimension disproportionately great, and while this obtains to some degree for the pelvic outlet, it is even more striking in the width of the upper pelvic brim. This unusual relative size of the false pelvis is contributed mainly by the ilia; of each innominate bone the ilium making up an unusually large proportion, and the pubic and especially the ischiadic portions being relatively small. The acetabulum on each side is sharply defined and in normal location. Each bears little resemblance to a socket, however, showing only the shallowest depression, but with some hypertrophy and thickening of the upper rim. The plane varies slightly, that on one side approaching more the vertical, but its depression appears the greater. The femoral shafts up to the trochanter regions are not remarkable. The mesial aspect of the shaft traced proximately widens inward toward the pelvis as if to form the inferior surface of the femoral neck but abruptly turns upward and, on the right, recedes outward until its line merges with the curve of the digital fossa. Above this lies an abnormally thick and high trochanter major, slightly rotated so that its digital aspect faces somewhat forward. Except for the trochanters, the femoral diaphysis thus ends with an extremely short cervical stump. Overlying the dense compact shadows of this stump is seen a rounded mass of cancellous bone of greater radiability which stereoscopically seems to spring from shaft anteriorly at about the site of what should be the trochanter minor. In form this mass slightly suggests the mushroom-shaped chondro-osteoma of the long bones. On one side, where the acetabular depression is more concave at the top, this projecting mass has a generally spherical contour,

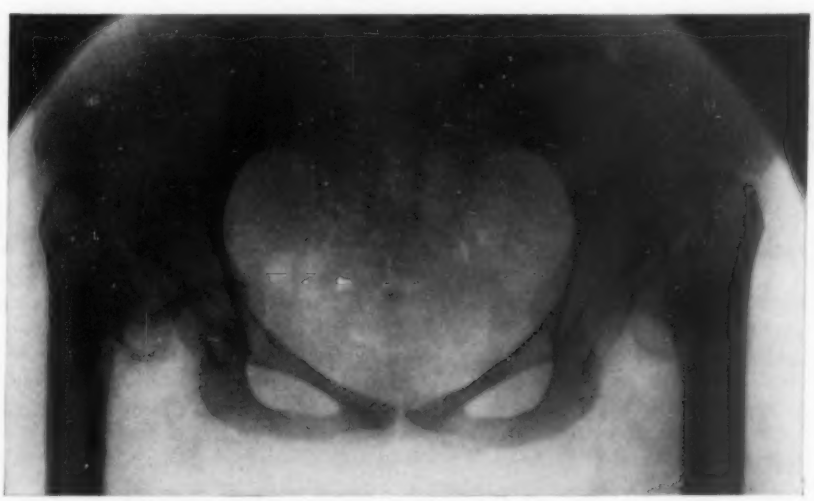

FIG. 1

See detailed discussion of roentgenographic findings in text.

but on the side of the flatter acetabulum the femoral projection is much flattened in its upper half with heavier internal trabeculae at right angles to this plane surface. Stereoscopically the trochanter major lies behind the dorsum ilii, the stump of the neck and upper shaft lie in a plane posterior to the acetabulum, and the bulbous mass springing from a point where should be found the lesser trochanter, definitely articulates with the deformed acetabulum. To the writer the impression strongly developed from the stereoscopic study that these articulations represented adaptive pseudarthrosis of the lesser trochanters with the pelvis.

Diagnosis: An anatomical diagnosis of coxa vara can of course be readily made and perhaps also coxa plana; but an etiological or pathological diagnosis seemed to us more intriguing. From the available data in this case the following points were felt to lend support to a supposition of congenital absence of the upper femoral epiphysis. The early history, which was believed quite reliable, seemed to indicate that there was some disturbance present at birth. While it might be held that the earliest defect was a congenitally flat socket, this alone would seem inadequate also to explain the marked deficiency of structure proximal or mesial to the trochanteric portion of the femur. An intra-uterine epiphyseal displacement might account for an eventual displacement or defective development of the femoral heads, but would not seem to entail the extensive defect of substance in neck of femur. Cases on record of this displacement of head have developed severe coxa vara, but with the neck of the femur but little shortened.

On the other hand, with the upper epiphysis primarily and completely lacking, the trochanters could form from the diaphyseal center without much difficulty, so that in infancy there would be a loose pseudarthrosis against the pelvis. It was noted that the child did not walk till age of three and during this period enough contraction of the capsule might have been taking place to eventually stabilize the joint and allow support of the body. Then followed a period of years in which the marked up-and-down movement of the hips, seen in congenital dislocation, was gradually decreasing. Natural adaptation during this period of time could bring about a gradual hypertrophy and proliferation in the region of the lesser trochanter until an effective bearing surface against the socket had formed and the hips became firmly stabilized, which apparently took place between the ages of ten and thirteen. Until stabilization was complete, another easily conceivable adaptation would have been hypertrophy of the great trochanters to supply a bearing point against the dorsum ilii and this enlargement would probably persist with little change after that age. The peculiar mass representing the articulating portion of the end of the femur is only as large as would be necessary to get bearing in the socket, with the application of the trochanters to the pelvis preventing any closer proximity of the base of the neck to the acetabula.

In conclusion, then, it is felt that the history, and the anatomical condition as seen by x-ray as well as by clinical examination, would fit in entirely satisfactorily with this tentative diagnosis. Conversely no other supposition that has occurred to us, such as prenatal or postnatal displacement, metabolic disorder, or inflammatory diseases, can be completely reconciled with the data at hand.

Treatment: The treatment of this interesting patient is apparently going to be a matter for subsequent determination. If later developments should indicate to her and to us that radical intervention is necessary and justifiable, we have felt that an operative procedure aimed at the mechanical defects might be considered. For instance, a curved Brackett osteotomy done just below the trochanters, followed by fixation and union in maximum normal abduction, (1) should restore the normal line between head and axis of limb; (2) would, when the limbs come down to neutral, unlock the trochanters from behind the pelvis, and (3) would carry the tip of the great trochanter far enough away from the ilium to provide a mechanically effective lever arm and normal length to the gluteal musculature. Of course there is no way of estimating whether the capsular ligaments would avail to stabilize these joints against a luxation in their new position, the sockets being so shallow. Such complication, however, might be subsequently met by an osteoplastic procedure in the ilium above the socket.

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THE TREATMENT OF OSTEOMYELITIS

With Special Reference to the Lower Third of the Femur*

BY LAWSON THORNTON, M.D., ATLANTA, GEORGIA

The reason for presenting this subject, about which much has been written, is that a procedure, based on simple physiological and mechanical principles, has been evolved which, when accurately carried out in operable cases, results in permanent healing. The interpretation of the microscopical and roentgenological changes as they occur gives one the information from which the procedures are planned. . . . For the sake of clearness we will take the liberty of being very elementary in this presentation. . . .

The life history of bone cells and the natural process of repair become of special interest to one who contemplates the treatment of osteomyelitis. Both in health and disease, bone cells obey specific natural laws with almost intelligent accuracy. The early changes which occur in bone in acute osteomyelitis are not revealed by roentgenograms, but a microscopical study would show that both destructive and productive processes were very actively taking place. In the diseased cortex and medulla, dead and dying bone cells in large and small areas are found surrounded by bacteria and leucocytes. Beneath the periosteum, in the diseased area, a very different picture is seen. The same bacteria and toxins which have destroyed the deeper bone tissues are here stimulating the formation of new bone. The same factor which produces the sequestrum by destroying the life of the bone, causes the periosteum to generate involucrum. A cross section through this subperiosteal area shows budding capillaries growing from the detached periosteum toward the diseased cortex. New bone cells are everywhere seen among the loops of minute blood vessels. Bacteria and leucocytes are in great numbers in this new granulation tissue. A section through a similar area at a later date would show that the osteoblasts have taken possession of this subperiosteal area and converted it into new bone. This young bone tissue is first seen in its cartilaginous stage, but as lime salts are deposited it soon resembles the new bone of callus formation in fractures. Bacteria and leucocytes are eliminated, and after a time it becomes healthy bone.

This microscopical study explains the reason why the roentgenogram does not reveal any changes in the early stages. If a series of roentgenograms be taken, the first evidence of disease is a mottled appearance of the bone. Areas of lesser density show where the disease is causing destruction and absorption of the cortex. The areas of greater density, if followed through a series of pictures, will be seen either to remain living bone or become sequestra. The involucrum which is first seen as a very dim shadow surmounting the cortex, in each successive picture, gradually

*Read before the American Orthopaedic Association at Atlanta, April 28, 1926.

assumes the density of normal cortical bone. Often nearly the whole shaft of a bone dies and becomes surrounded by involucrum of sufficient strength to assume weight-bearing function.

In the early stage of the disease, drainage by incision is an emergency measure, and the more quickly drainage of the medullary canal is established the less extensive the disease and the less the prostration of the patient. . . . After adequate drainage has been established a period of watchful waiting ensues. During this time the diseased bone undergoes a gradual process of repair. The patient, who is usually critically ill, slowly regains health.

INDICATIONS FOR RADICAL OPERATION

When it is learned from roentgenographic study that the process of repair has progressed to such a stage that the line of demarcation between the dead and the living bone has become well defined, and when enough new bone has formed to insure the strength of the shaft of the bone, then radical operation is indicated.

INOPERABLE CASES

For convenience, we have classed osteomyelitis as operable and inoperable. Those cases in which a complete sculptural operation may be done, removing all sequestra and penetrating bone sinuses without too greatly endangering the continuity and strength of the remaining healthy bone, are operable.

In youth almost unlimited bone growth may be depended upon to repair bony defects, and for this reason there are more operable cases in childhood than in those beyond the age of maturity.

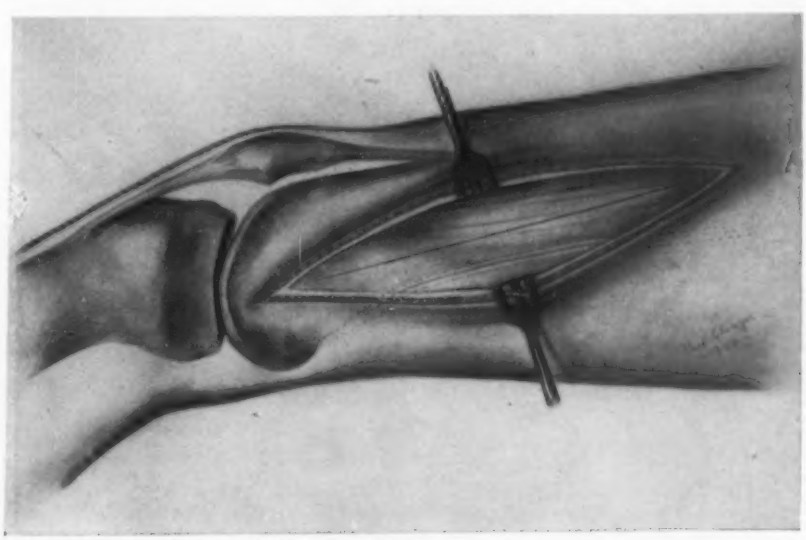

FIG. 1

Shows the incision along the inner surface of the thigh.

Following the acute stage of the disease in every case there is a period of time when the condition should be considered inoperable but eventually may become operable. During this time the disease is diffuse. Roentgenograms do not show clear cut lines of demarcation between the devitalized and living bone; the involucrum has not become calcified and strong. *If an operation should be done at this stage it would be worse than useless. Much good bone might be sacrificed and diseased and dying bone left, making subsequent operations more difficult.* However, each successive roentgenogram shows the line of demarcation between the devitalized and living bone becoming more clearly defined, and the new bone appearing as a denser shadow on the film until at length the process of repair has progressed to such a degree that a complete sculptural operation might safely be performed. . . . Occasionally the process of repair does not conform to this well laid plan but instead the disease may remain diffuse. If it remains diffuse, it is inoperable. The whole shaft and its medulla may be replaced by a homogeneous diseased bone which may even obliterate the medullary canal. Usually there are no sequestra present in this latter type of case. A complete operation here would be impossible, of course, because all diseased bone could not be removed without complete excision of the shaft, an inadvisable procedure. When the disease extends into an adjacent joint the problem becomes more complicated and often is considered inoperable.

THE SCULPTURAL OPERATION

When it is decided that a case is an operable one, the procedure is

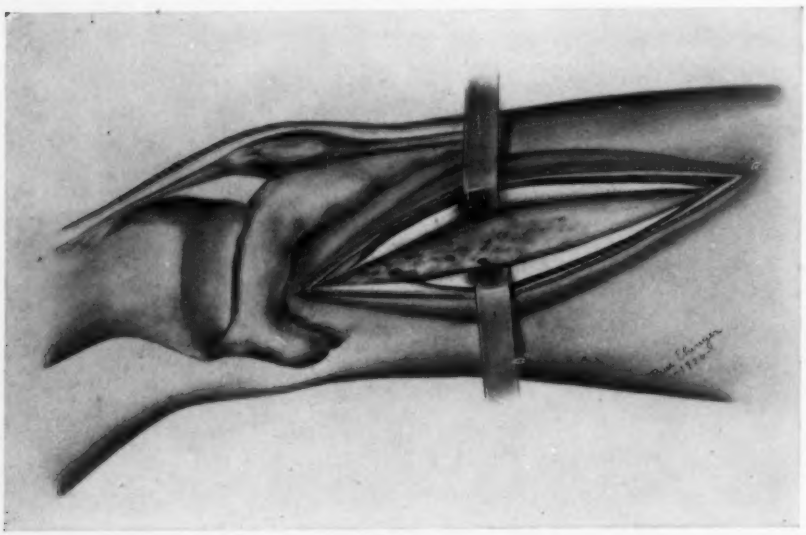

FIG. 2

Shows subperiosteal exposure of the diseased bone. The joint capsule is drawn in the picture to show that the incision may safely be extended well down on the condyles of the femur.

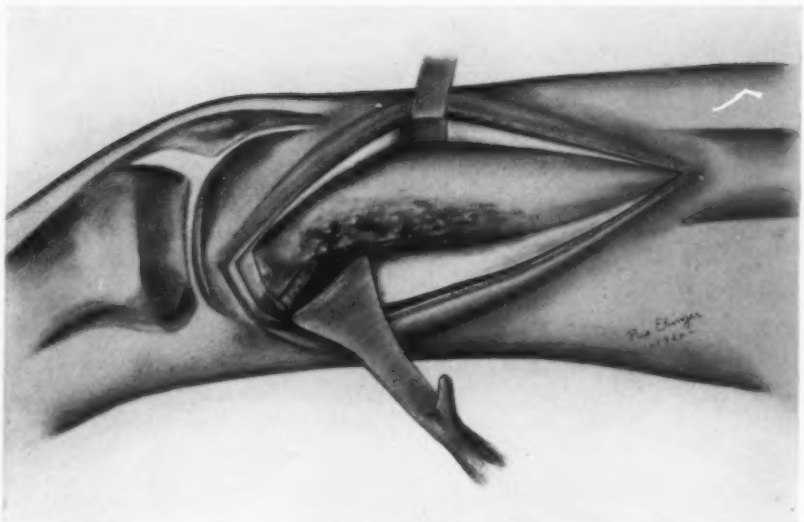

FIG. 3

Shows the inner and posterior surface of the lower third of the femur exposed subperiosteally.

carefully planned. Stereoroentgenograms, both anteroposterior and lateral, give one a clear mental picture of the location of bone sinuses, sequestra and the healthy bone that is to be left undisturbed.

The operation is a sculptural procedure designed for the complete removal of all devitalized bone, and to change the contour of the remaining bone so that natural healing may occur.

Plain vision of the bone while being carved is essential. The procedure could not be accurately executed without a bloodless field of operation; therefore, a tourniquet should be applied. The incision should be planned so that the sculptural procedure may be done without hindrance, which would be caused by a poor exposure or a difficult approach.

The periosteum is deflected from that portion of the bone to be removed, and wherever possible left undisturbed over the remaining bone. Very sharp chisels and a machinist's hammer are used. The sculpturing must be done boldly but with great care. *An incomplete operation is a useless one and means persistence of the disease. The operation is the crux of the cure. When a complete operation has been done permanent cure may be expected.* . . . It is absolutely essential that all bone sinuses be eliminated regardless of the amount of good bone that has to be sacrificed because an infected penetrating bone sinus will not remain healed. Deep cavities must be made shallow and everywhere the bone should be made smooth.

There is almost no loss of blood after such an operation, and very little shock even in extensive operation on the femur. . . . At the completion of the operation the wound is packed snugly with dry gauze, and dressings applied. If the bone has been weakened to the point of danger of fracture, a plaster cast is applied for its protection.

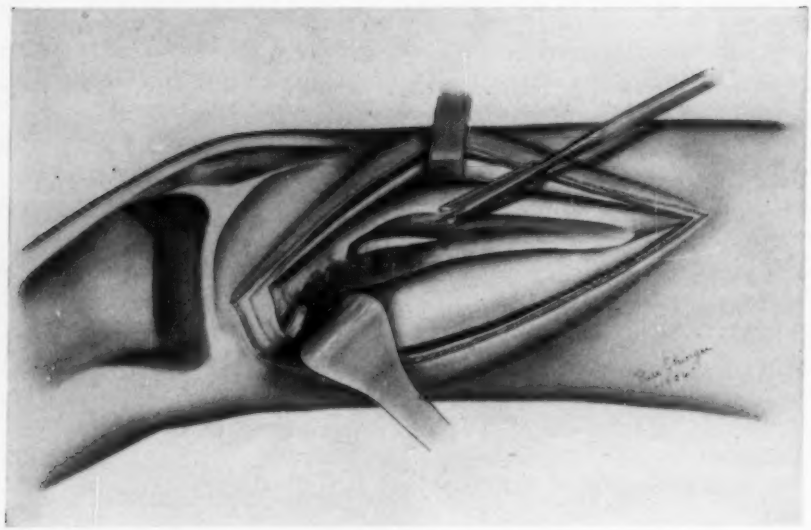

FIG. 4

Shows the carving away of the posterior cortex along with sequestra and other diseased bone.

HEALING

When the sculptural operation has been done thoroughly and completely, as outlined above, healing is assured regardless of the postoperative method of treatment. . . . Briefly, the healing process occurs as follows: Minute blood vessels and capillaries grow out from the periosteum and surrounding soft tissues. These blood vessels grow rapidly over the exposed

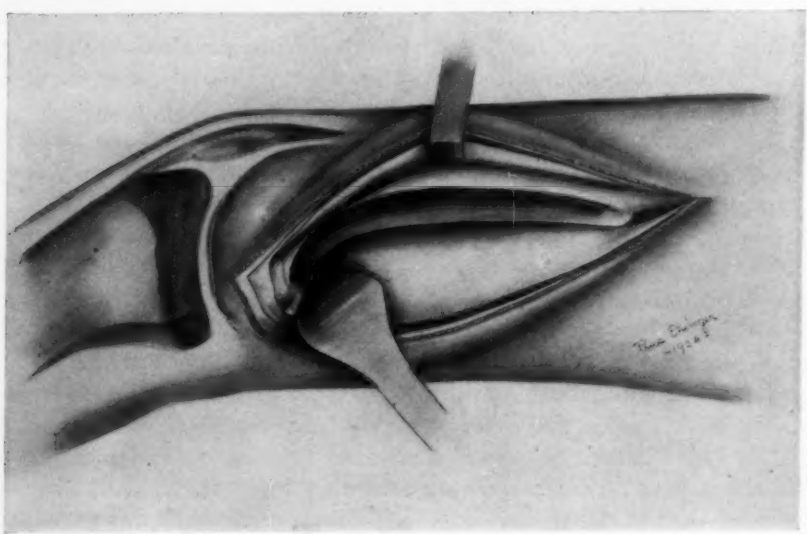

FIG. 5

Shows the sculptural operation completed.

bone surfaces and are apparent as granulations. The budding capillaries are accompanied by fibroblasts and osteoblasts. This invading granulation tissue is destined to form bone, and to repair the defect caused by the disease and the chisel. The granulation tissue furnishes food for the osteoblasts and newly formed bone cells. The bone cells proliferate, displace the granulations and form normal bone tissue. Concavities that are too deep do not heal because the granulations become choked off by scar tissue formation before they have spread to the depths.

Five days after the operation the first dressing may be done under gas-oxygen anaesthesia. The gauze packing is removed and the wound is usually found to be surprisingly clean, and little or no bleeding occurs. After cleansing the skin surfaces, vaseline gauze is loosely packed into the wound and dry dressings applied. Following the first dressing, daily dressings are made, employing aseptic technique, and keeping the skin around the wound scrupulously clean. At each dressing the vaseline gauze is removed and replaced without pain and without injury to the newly formed granulations, bringing with it almost all the secretions from the wound. When the bone defect has filled with granulations the scar may be excised and the wound closed or partially closed by suture, thus shortening the time of healing, eliminating much scar tissue and making a neater result.

OSTEOMYELITIS OF THE LOWER THIRD OF THE FEMUR

What has been said in the preceding paragraphs applies to osteomyelitis in general, as well as to the lower third of the femur. This portion of the femur is a very frequent site of the disease and on account of its anatomical position, disease in this area represents a more difficult problem. . . . It is apparent, as illustrated in the accompanying drawings, that a free exposure is obtained, and that a radical sculptural operation may be done with thoroughness, as well as safety, for the knee joint and the popliteal vessels. We prefer the inner surface of the thigh for this exposure whenever possible because, (1) the destruction is usually greatest over the inner posterior cortex; (2) healing probably occurs more readily here where the thick vastus internus muscle may fall into the bone cavity, while on the lateral surface the adjacent tendons and dense fascia do not lend themselves so kindly to the healing process. . . . A very similar incision is made on the lateral surface when it is considered the site of election, especially when the disease extends upward beyond the lower third.

The lower third of the femur is often the site of a true chronic osteomyelitis where the disease is apparently limited to the medullary canal, as is evidenced by an almost negative roentgenogram. There may be no involucrum and no sequestra. Only a small area of lessened density in the posterior cortex indicates the presence of a small opening in the thin cortical bone which forms the roof of the popliteal space. Through this small opening a lake of pus in the medulla is draining. This type of case is treated successfully in the same sculptural manner as has been described.

SUMMARY

(1) Early drainage of the medullary canal, of course, is an emergency measure.

(2) Too early radical operation is worse than useless, sacrifices bone unnecessarily, thus interfering with subsequent treatment.

(3) The classification of "operable" and "inoperable" chronic osteomyelitis is defined.

(4) Indications for radical operation are given. The term complete sculptural operation is defined. Complete and permanent eradication of the disease may be expected following a thorough sculptural operation.

(5) Incomplete sculptural operations are useless.

(6) The operation is the crux of the cure.

DISCUSSION

DR. R. B. OSGOOD, Boston, Mass.: I have seen these drawings at close hand. It is pleasant to see that the spirit of the master has entered a very faithful disciple and that the same careful study is being applied to his cases. I have seen him work, not only following the master but often giving the master very important suggestions. Dr. Thornton is to be congratulated.

DR. J. P. LORD, Omaha, Nebr.: I feel that we are all indebted to Dr. Thornton for his splendid presentation because it is the experience of all of us that there has been no definite understanding in regard to the proper approach to cases of osteomyelitis of the lower end of the femur. I was especially impressed with his pains in taking the numerous roentgenograms. I think he established in his mind a very definite idea as to just what approach to make and to make it with lessened disturbance, with proper access and with minimum destruction of bone.

The Carrell-Dakin method for these osteomyelitic cases taught us how to close extensive defects in the bone by two-stage procedures. It has been my experience to have a number of cases of very extensive osteomyelitis in the lower half or two thirds of the femur; sometimes it has extended well into the condyles of the femur, and in perhaps fifty per cent. or more the problem of closure of these defects was a real one. I want to call your attention to a method of closure and more particularly an immediate closure in these cases in civil practice where the infection has run its course. Many of these cases have existed from five years upwards and in one case twenty-four years with about one operation per year. Actually one patient had what he alleged was twenty-four operative procedures. The problem was to get rid of the disease and get early closure, it being my conception that the infection had run its course and that it was not necessary to Dakinize an open wound and close secondarily. I therefore made this tremendous excavation and cleaned out the bone from both sides, so that we simply had a large anterior and posterior shell of bone. In one particular case there was an ankylosis of the knee, thereby making it possible to extend the flaps below the joint and long enough to give pedicles that I could overlap across each other in the condylar cavities to close this enormous opening. The sutured skin closed the lateral wounds. The Carrell-Dakin irrigation was instituted. The tubes were rendered patulous by first using citrate of soda, 2 per cent., then gradually establishing the Dakin irrigation after the patient was returned to bed. Therefore the tubes were kept free of blood clots. This irrigation was maintained from the start, so that in six cases I got what I call primary-secondary union, the patients being ready to go home within two to four weeks fully healed.

I think this point is well taken that it is ordinarily not necessary to do the ordinary chronic cases in two stages. It is possible to do them in one stage as I have proven to myself.

I conceived a skin flap operation from the method of Emil Beck in treating empyema. Therefore in cases with a cavity extending through the head of the tibia this

method has been very practical. I was thus enabled to establish early healing and discharge the patient who had eight unsuccessful operations. One patient in whom I employed this method had had fourteen operations. Fifteen or twenty years ago I had a similar condition to this in the tuberosity of the tibia which had an enormous cavity nearly as big as a golf ball. The patient told me that he was not going to stay in the hospital all summer. So I skin-grafted, slipping in Thiersch grafts, and the old man was home taking care of his chickens in four weeks. I am simply offering these methods as a means of getting the patients out quickly, after having gotten rid of the disease. It is my experience that these means of closure hasten the cures.

Dr. F. J. Gaenslen, Milwaukee, Wis.: I feel that Dr. Thornton has presented a very excellent paper. The difficulties involved in the treatment of osteomyelitis of the lower end of the femur, I am sure, are appreciated by all. No doubt, too, all of us have experiences which will bear out the pathological and clinical observations which he has made. I am heartily in accord with practically all that the writer has said but feel that it is an added advantage to dress the wound less frequently and to insure complete immobilization of the part.

Several years ago Dr. Orr read a paper on the treatment of chronic osteomyelitis. The essential points in the treatments outlined by him were (1) proper surgical attention, (2) immediate packing of the entire wound flush with the skin with vaseline gauze, (3) complete immobilization in plaster cast without fenestration of the cast for dressing. On first reading, this procedure seemed rather hazardous and I did not have the courage to employ it. About a year later, however, after having had an opportunity to discuss the matter with him, I used it in several cases and since then the method as described by Dr. Orr has become our routine treatment.

As Dr. Thornton has said, no method can be successful unless the surgical work is thorough and complete. We have found that the convalescence is so uneventful that we do not hesitate to let these patients leave the hospital two or three days after operation with instructions to return for removal of cast in three or four weeks. The odor by this time is very offensive and a gentle cleansing of the wound and removal of the vaseline pack and cast is welcomed by the patient and family, as well.

The vaseline pack, we feel, is of great value: first, because it keeps the wound edges widely apart, the drainage of secretions between the wound and the vaseline mass being unhindered and, second, because it fills the wound with a plastic mass exerting a beneficial surface pressure on the granulating tissue. This prevents lymph stasis and the granulations are smooth, firm and pink. The plastic vaseline mass recedes only slowly; in fact, it is pushed out of the wound as the granulation tissue fills in the bottom. Dr. Blair of Washington University, St. Louis, has called attention to the importance of surface pressure on wound healing and I believe that this feature will probably account for the efficiency of the vaseline pack in the treatment of osteomyelitis. Be that as it may, the clinical results have been perfectly satisfactory so that the method as outlined has become our method of choice. The value of the complete immobilization in plaster cannot be overestimated, it is an extremely important aid in nature's fight against infection. If the defense barriers to infection are broken down repeatedly, as they will be when the part is allowed even slight motion, the resistance is diminished and healing is delayed. If the barriers once formed are protected and maintained by complete rest, healing will take place uninterruptedly.

In the early cases, as Dr. Thornton has said, nothing can be done but a drainage operation. Until the x-ray shows a well formed strong involucrum the case should be regarded as inoperable and this was well emphasized by the speaker. I think Phemister, some years ago, showed that the sequestrum being shut off from the circulation retains all its calcium salts and therefore stands out clearly in the surrounding atrophic bone.

Dr. Thornton is to be congratulated on the unusually high percentage of successful secondary closures. In certain cases with extensive involvement of the lower third of the femur with only the anterior and posterior walls remaining after eradication of the disease, Henderson, I believe, has cut through this anterior wall above and below and so sunk the mobilized anterior portion of the shaft together with soft parts into the cavity with good results. I have also found this of help and can recommend it in suitable cases.

RADIOGRAPHY DURING MANIPULATION FOR CLOSED REDUCTION OF CONGENITAL DISLOCATION OF HIP

BY SAMUEL W. BOORSTEIN, M.D., F.A.C.S., NEW YORK

While the experienced orthopaedic surgeon, using the closed method of reduction of congenital dislocation of hip, can tell fairly well when the head of the femur is in position, still he frequently finds that in some cases he was mistaken. Most orthopaedic surgeons can recall cases when they heard the click as the head went in, yet the radiogram afterward showed the head at the rim of the acetabulum. Very often at the time when the first plaster is changed, the head is at the rim instead of inside the acetabulum and then, of course, it slips out during the manipulation of changing the plaster.

The difficulties of proper reduction and retention need not be discussed here as they have been so ably explained in the papers of Galloway, Farrell and Willard and in the discussion that followed, at the last meeting of the American Orthopaedic Association.*

Occasionally one also finds difficulty in deciding the most advisable angle for the position of the thigh for the second or third plasters. Assistance is sometimes needed in deciding the proper angle of flexion and abduction in the first plaster.

Some time ago it occurred to the author that since many surgeons are still reducing hips by the closed method, use might be made of radiography before the plaster is applied. The radiogram is not always a perfect criterion of the position of the head. Occasionally the position of the hip as shown by the radiogram is worse than the actual condition. Still, we may confidently rely on the radiograms and ignore those few rare instances where the radiograms are misleading.

In reducing fractures we have learned that better results are obtained when done under the fluoroscope, or when the radiograph is taken before the plaster is applied. The reduction of a fracture is therefore carried out in the radiographic room, either in the hospital or at a private laboratory. A similar procedure may be followed with the reduction of a hip by the closed method. It can be done in the radiographic room on the radiographic table. It is not safe to use the fluoroscope for so long a time as during the entire manipulation. However, a radiograph can readily be taken as soon as one feels that the hip has been reduced or that the position for the change is good. The radiographer can develop the plates while the child is still kept under ether. It takes only about eight minutes for the development of plates (five minutes in the developing solution and three

*Two of these papers and the discussion were published in *The Journal of Bone and Joint Surgery* of July 1926. The third paper appears in this issue.

FIG. 1. CASE 1

Dorothy W. Showing the left hip not in as good position as right. This hip later on slipped out. (In subsequent cases a hip like this was considered unstable.)

minutes in the fixing solution) and the plate is read wet. In most of the laboratories the dark room is near the radiographic room thus reducing the time of ether to a minimum. The assistant holds the hips all the time so as not to lose the position. If the surgeon is dissatisfied with the position, he changes it and has another radiogram taken. If, at the time of change of the plaster, he is not certain which angle is preferable he can take a radiogram in two positions, have both developed and then choose the best position for the plaster (Figs, 4, 5, and 6). After the plaster is applied and is dry, another print is made to be positive of the position and for the sake of a permanent record.

The author has used this procedure for some time and found it of great help. There has been no difficulty in taking the plaster outfits and the spica box to any laboratory and carrying out the reduction there.

FIG. 2. CASE 1

Dorothy W. After manipulation. Left head in fair position but almost like the one in Fig. 1.

The citation of a few cases in which this procedure was of distinct benefit may prove interesting.

CASE 1. Dorothy W., a girl of four, with double congenital dislocation. Both hips were reduced. Right one stayed in, while left was at edge of rim of acetabulum at time of changing of the first plaster (Fig. 1). The left head slipped out in a few weeks. The left hip was reduced again, a new plaster was applied and when the radiograph was taken on the second day, the head was in exactly the same dislocated position as before. To avoid immediate trauma the plaster was left on for a few weeks. The plaster was removed in the radiographic laboratory, hip was reduced and two radiographs, one in acute position and one in ninety-ninety position, were taken while the child was still under the ether. The position of acute flexion was preferred (Figs. 2 and 3). A plaster was applied and no more redislocation occurred. This was the first case in which I used the radiograph during manipulation and it was the cause of my resorting to this procedure in subsequent cases.

Comment: At the time of the second reduction the plaster possibly would not have been applied had the radiograph been taken and the head found out of the acetabular cavity. At the next reduction, by taking the radiograph before the application of the plaster, the position of the hip was known.

CASE 2. Charlotte E., a girl of three. A double congenital dislocation was reduced in the radiographic room. When second plaster was applied with hips at angle of one hundred and fifty degrees, the left was at the edge of brim. Left hip slipped out within a month. Reduction was then repeated. Radiographs in three positions were taken and the one in acute flexion selected as in this position the head was deep in the acetabulum (Figs. 4, 5, and 6). Plaster was applied. After three months it was safe to resume the ninety-ninety position. Child made a perfect recovery.

Comment: The taking of the radiograph at the time of changing the plaster or when the left hip was reduced again determined what angle was most advantageous.

CASE 3. Sarah L., a girl of five, with dislocated right hip that had never been treated. Measurements showed there was one and one-half inches shortening (Fig. 7). A Thomas Jones splint was applied and traction used at first. In five days the hip came down about one inch (Fig. 8). We then reduced by Denucé method. Reduction was easy and the position of ninety-ninety was shown to be quite safe (Fig. 9).

FIG. 3. CASE 1.

Dorothy W. Left head put in acute flexion. Note that the head is deeper in the socket or almost below the acetabulum. This position was selected.

FIG. 4. CASE 2

Charlotte E. Radiogram after the manipulation before the plaster was applied. The left hip at an angle of 150 degrees compared to the right at 150 degrees. Hip distinctly out.

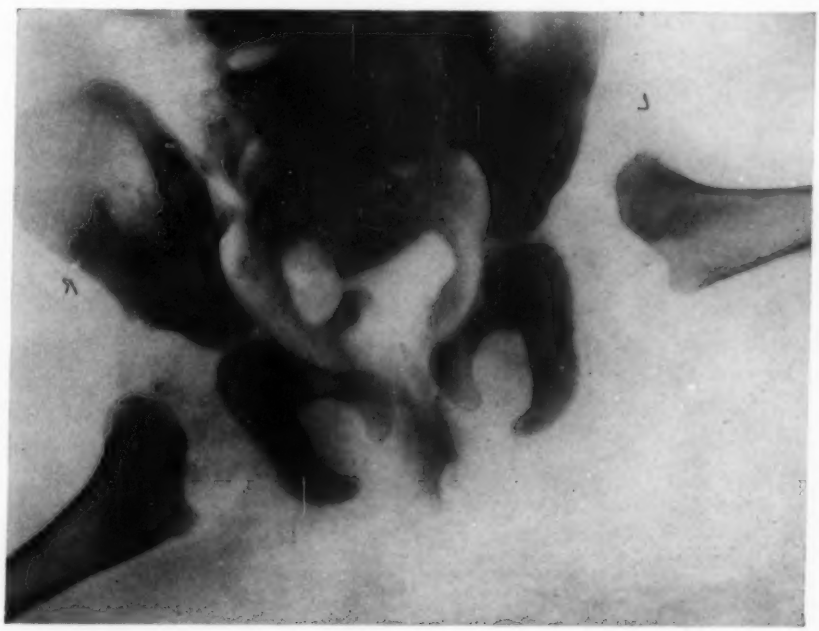

FIG. 5. CASE 2

Charlotte E. Left hip at 90-90. While it looked in good position it was considered unsafe. (Compare this to Fig. 1.)

FIG. 6. CASE 2

Charlotte E. Radiogram after the manipulation before the plaster was applied. Left hip in acute flexion. This position was selected. (Right hip in good position.)

CONCLUSIONS

1. Closed reduction of congenital hip as well as changing of the plasters can be helped materially by having radiographs taken before the application of plaster.

2. The reduction and the application of plaster should be done in the radiographic room on the radiographic table.

FIG. 7. CASE 3

Sarah L. First radiograph before treatments. Right hip almost under the anterior superior spine.

FIG. 8. CASE 3

Sarah L. After traction for five days. Note the position of the head almost at the rim of the acetabulum.

FIG. 9. CASE 3

Sarah L. After manipulation before plaster was applied. Note good position.

3. The procedure helps one to decide the most advisable position to choose and indicates when it is safe to bring the hip down.

4. It obviates the necessity of removing and reapplying plaster if the position was not correct or safe.

Acknowledgment: Most of the radiographs were taken either at the laboratory of Dr. I. J. Landsman or of Dr. E. Fox. I wish, therefore, to express my thanks to them for their valuable assistance and for many helpful suggestions that facilitated the radiography.

OSTEOMYELITIS OF THE SCAPULA*

Report of a Case

BY GEORGE A. WILLIAMS, M.D., ATLANTA, GA.

Acute haematogenous osteomyelitis is a disease which fills the surgical wards of our hospitals but it so seldom attacks the scapula that statistics upon its frequency are scarce. Most writers merely mention that the scapula is rarely affected[1]. Strauss[2] in 1911 found thirty-six cases in literature. Heinonen[3] reported the disease localized in the scapula in four, or .42 per cent., of the nine hundred and forty-two cases of haematogenous osteomyelitis treated at the University Hospital, Helsingfors, in twenty-five years. He brought the total number of reported cases to forty-six and since then another[4] has been added.

The clinical course of the disease follows closely that of osteomyelitis elsewhere in the body. The spine of the scapula is usually affected. The coracoid process has been found to be involved only once, in spite of the fact that it contains a relatively large amount of bone marrow. The diagnosis offers no unusual difficulty but the condition must be differentiated from acute infections of the shoulder joint, osteomyelitis of the ribs, and malignancies of the scapula. In only one reported case has there been definite history of trauma.

Conservative operative treatment is usually successful but complete resection of the scapula in extensive cases has found some advocates. The following case responded well to simple removal of the diseased portion of the bone.

J. D., a colored boy, age fourteen, entered Grady Hospital, Emory University Division, December 7, 1925, complaining of a draining sinus in the left scapular region.

The family history and past history were unimportant. There was no history of syphilis or tuberculosis.

The present illness began August 15, 1925, with severe pain, swelling and disability in the left shoulder. There was moderate fever and general malaise. After a few days fluctuation occurred and a pocket was opened by his mother, who considered it an abscess. The acute symptoms gradually subsided but the drainage continued. In October he came to the outpatient clinic where x-ray studies were made and the diagnosis of osteomyelitis of the scapula was established. Operation was refused but when there was no improvement after four months he entered the hospital.

Physical examination revealed a well developed, well nourished colored boy apparently normal except for the left scapular region. There was a moderate induration over this area which made the outlines of the scapula indistinct. A draining sinus about 3 mm. in diameter, with everted edges, was present over the middle of the spine of the scapula. The surrounding skin was considerably discolored. There was very little pain on palpation and only slight impairment of motion. The ribs were not tender to palpation and the lungs were normal throughout.

*From the Department of Surgery (Orthopaedic Surgery), Emory University School of Medicine, Service of Dr. F. G. Hodgson.

A blood count revealed a leucocytosis of 14,400 with a normal differential count. Urinalysis was negative. Blood Wassermann on admission was weakly positive but previous and subsequent tests were negative.

X-ray showed an increase in bone density along the spine of the scapula and a hazy outline of the superior margin and scapular notch.

At operation under ether anaesthesia, the sinus was excised and the incision extended medially and laterally over the entire spine of the scapula. This was found to be necrotic, consisting of several fragments of sequestrum. The sequestra were removed and the spine thoroughly curetted down to the underlying bone which was very hard and dense. The process seemed to be entirely limited to the spine. The wound was only partially closed and the cavity was packed with dichloramin-T gauze.

Drainage became very profuse on the fourth day, after which it gradually diminished until it ceased entirely eight weeks later. At the present date there has been no recurrence and the patient has been occupied with manual labor for six months. All limitation of motion or other disability has disappeared.

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24 DOCTORS' BUILDING,
ATLANTA

THE HISTOGENESIS OF CARTILAGE AS SHOWN IN CHONDROMATOSIS OF THE KNEE JOINT*

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I recently studied a specimen removed at operation in a case of chondromatosis of the synovial membrane of the knee joint which showed, in a very remarkable manner, the stages of development of cartilage from the relatively undifferentiated connective tissue of the synovial membrane. In my report of nineteen cases in 1924 I was unable to demonstrate this process. The case presented here is unique in that the bodies were composed entirely of cartilage and cast no shadow in the roentgenogram comparable to that ordinarily shown by "joint mice".

FIG. 1

Knee joint containing countless cartilaginous joint bodies. Note absence of shadows ordinarily cast by "joint mice".

REPORT OF CASE

A man, aged twenty, registered at the Mayo Clinic February 18, 1926, complaining of pain in the right knee joint on motion. The trouble started a year and a half previously with "little twinges of pain" in the knee when he walked; these grew progressively worse. The discomfort varied with the amount of use. Occasionally after he had walked about a mile he experienced pain in the opposite knee.

The patient appeared healthy but limped because of a disabled right knee, which was 1.5 cm. greater in circumference than the left. Extension of the knee joint was limited to 170 degrees and flexion to 90 degrees. The significant feature of the examination was the sensation of crepitus on palpation. Many little bodies could be felt rubbing on each other within the joint. Judging from the enlargement, there was diffuse involvement of the entire knee joint including the popliteal space and suprapatellar pouch. In the distal part of the popliteal space there was a firm rounded enlargement about 2.5 cm. in diameter, which moved with the head of the tibia.

On February 25, the right knee joint was explored through a split patellar incision. The synovial membrane was thickly

*Submitted for publication December 2, 1926.

studded by wart-like, pearly cartilaginous bodies, practically all of which were attached, if only by a thread of tissue. Most of them seemed to originate from the margin of the joint where the synovial membrane joined the bone. The suprapatellar fat pad was displaced anteriorly by a cartilaginous mass 2 cm. in diameter. The intercondylar notch was likewise filled with masses of cartilage. It was impossible to count the bodies without destroying the specimen but the number was well into the thousands. As much of the synovial membrane as possible was removed together with the bodies.

The incision healed without trouble and, on March 8, the posterior compartments of the joint were explored through the external and internal posterolateral incisions described by Henderson. The bodies were closely packed, forming a cast of the posterior compartments of the joint. The cartilaginous mass was removed as completely as possible. When the knee was flexed firm adhesions could be felt to break.

The point of chief interest in this case is the formation of cartilage, which is a most unusual illustration of the embryonic method of the development of cartilage from mesenchymal tissue, as described by Mall. According to Mall, "Mesenchymal cells first give rise to an ectoplasm in which fibrils develop. Next some of the cells increase in size and are gradually extruded until they lie in the spaces of the ectoplasmic matrix. Simultaneously the ectoplasm undergoes both a chemical and a structural change, being converted into the hyaline matrix peculiar to cartilage. About the cartilage cells the endoplasm produces capsules of hyaline substance."

The microscopic data in this case graphically portray the histogenesis of cartilage just described. Figure 3 is a section of the synovial membrane shown by low magnification, illustrating succeeding stages in the development of hyaline cartilage. The areas indicated by the rectangles are shown in Figures 4 to 7 by high magnification.

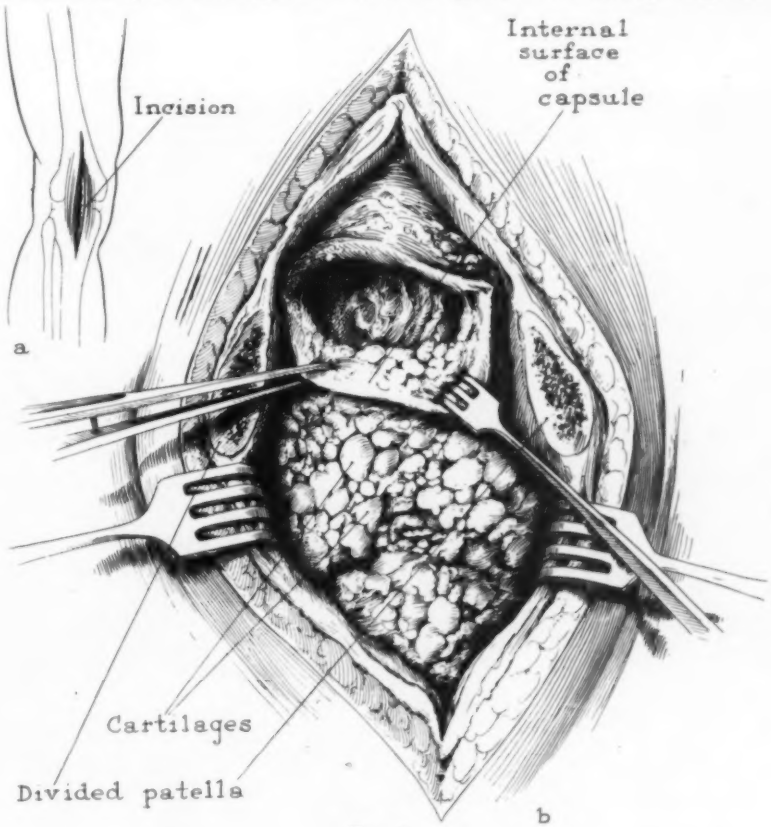

FIG. 2

Interior of the knee joint at operation.

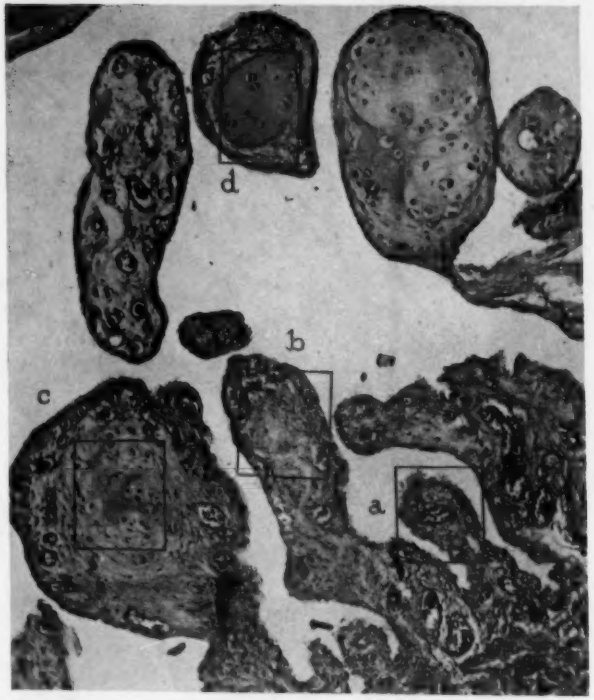

FIG. 3

Section of synovial membrane showing succeeding stages in the development of cartilage. Rectangles of the section designated: *a*, *b*, *c*, and *d* are shown more highly magnified in Figures 4 to 7.

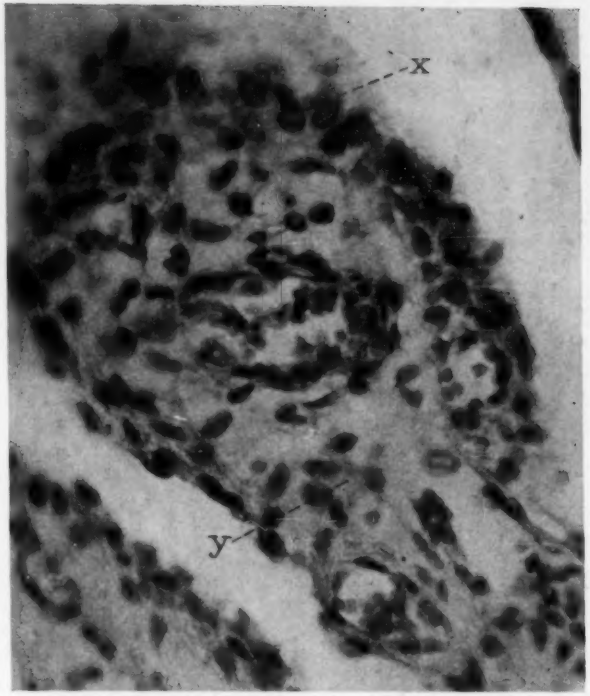

FIG. 4

Normal villus (Rectangle *a*, Fig. 3); superficial cells of villus at *x* are similar to deep cells at *y*.

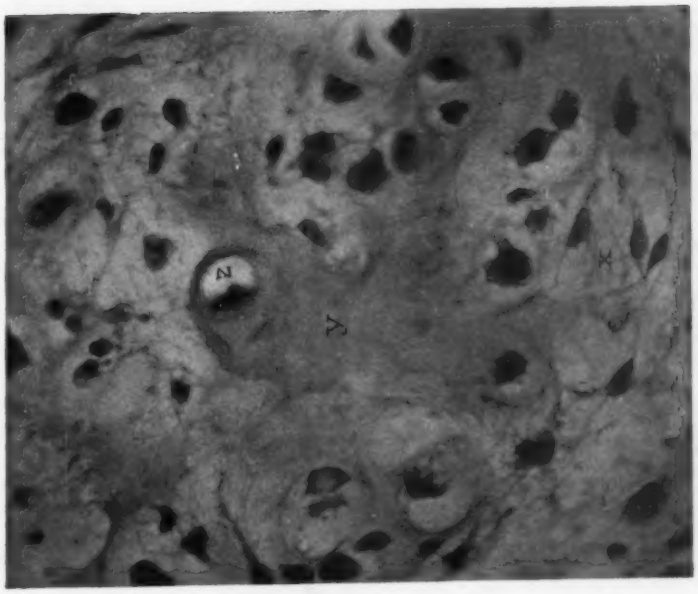

FIG. 6

Center of another villus (Rectangle *c*, Fig. 3); *x* fibrillated exoplasm; *y* hyaline substance having replaced fibrillated structure; *z* cartilage cell in cell space.

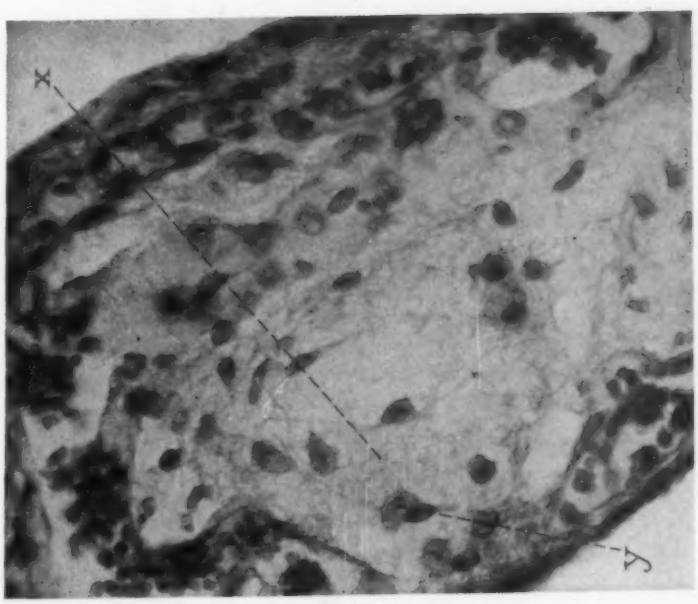

FIG. 5

Another villus (Rectangle *b*, Fig. 3); *x* fibrillated exoplasm; *y* vacuolated endoplasm.

FIG. 7

Center of another villus (Rectangle *d*, Fig. 3); *x* hyaline matrix of cartilage; *y* well differentiated cartilage cells in cell space; *z* large vacuoles in endoplasm of cartilage.

Figure 4 (corresponding to rectangle *a* in Figure 3) shows a section of a villus which is quite normal in appearance. It may be noted that the superficial cells differ but little from those situated centrally. They are all of the endothelial type, but apparently the cells situated centrally are the ones that develop into cartilage. Figure 5 (corresponding to rectangle *b* in Figure 3) shows evidence of a decided change. The cells within the villus are more widely spaced, a fibrillated ectoplasm (*x*, Fig. 5) consisting of numerous spider-web-like strands has developed, and vacuolated endoplasm may be seen definitely in the cell at *y*, Figure 5. Figure 6 (corresponding to rectangle *c* in Figure 3) illustrates a succeeding stage. Some of the fibrillated ectoplasm may still be seen at *x;* at *y* this structure has been changed to a hyaline matrix and within this matrix at *z* may be seen a cartilage cell in its hyaline capsule. In Figure 7 (corresponding to rectangle *d*, Figure 3) more completely differentiated hyaline cartilage may be seen. At *y* (Fig. 7) may be seen again the cartilage cells in the cell space within the hyaline capsule. Judging from the large vacuoles in the endoplasm of the other less mature cartilage cells, *z* in this section, and remembering the small vacuoles in the endoplasm of the less differentiated cell *y* (Fig. 5) it is reasonable to suppose that, as these cells differentiate, the vacuoles become larger and confluent, and the endoplasm about the vacuoles produces the appearance of the capsule which surrounds the nucleus of the mature cartilage cell.

The fact that the formation of cartilage in this synovial chondroma follows closely the embryonic method of development of cartilage offers definite support for the theory that synovial chondromatosis is a neoplastic manifestation.

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INDICATIONS FOR OPERATIVE TREATMENT OF CONGENITAL EQUINOVARUS CLUB-FOOT

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Congenital deformities which are grouped under the term of equinovarus present a great variety, influenced on the one hand by the age of the child and on the other hand by the degree of the deformity which differs greatly in the different subjects. The duration of the deformity and the type are the special factors which influence the advice given for treatment and add to the difficulty of the problem, for it is evidently impossible to formulate a simple method of treatment which could apply to all cases. On the other hand, the very considerable number of methods of treatment, which have often been previously advised for the case when first seen, is frequently a cause of difficulty in determining the treatment. Often the individual preference of the surgeon, rather than the indications, have influenced the advice which has been given by some orthopaedic surgeons, who are accustomed only to manual manipulation and mechanical treatment, and who have attached an excessive value to these methods, and have been influenced in their prognosis as to the time of necessary treatment; and, on the other hand, by surgeons less familiar with the resources of orthopaedic surgery and methods of manipulation, and who often neglect to employ these simple means in the stage when they are most thorough and efficient. It is proposed in this contribution to attempt to present the methods of treatment which may be applied in the various types of congenital equinovarus, considering at the same time the age of the patient, and the type and degree of the deformity, and trust by these methods to encourage the use and the practice of the means which we have found of value in our experience.

PERIOD OF COMPLETE REDUCTIBILITY

At this time the deformed foot can be reduced to a position of overcorrection without excessive violence. It does not suffice to merely correct the foot to a position of intermediate equilibrium, in order to consider that the statics of the foot are normal. It is necessary to be able to carry the foot manually to a position of pronation and hypercorrection in order to legitimately consider that a complete manipulative correction has been obtained. It is possible to obtain the complete reduction practically always in the early days of life, sometimes this reduction may be completed

by the fifteenth day, in others this deformity persists to the age of even twelve or fifteen months. In this early period the manual reduction alone may be sufficient, but it must be remembered that to reduce alone is not sufficient; it is necessary to retain the correction. Between each attempt of mobilization, and it should be performed four times daily, the position of hypercorrection should be maintained by means of some light apparatus, for which in our cases the extremely simple brace called the modified splint of St. Germain, is used. For about three months this apparatus is worn both night and day, and if at the expiration of this time the correction happens to be complete, it may then be kept in place during the night only. But this precaution should be observed during a year at least, and sometimes longer, and even after this period it is advisable to apply the apparatus fifteen days each month.

The relapse of the deformity is frequent in some cases, but one should not accuse the surgeon for having imperfectly performed the reduction, neither should one accuse the mother for having imperfectly applied the splints, or whatever apparatus for retention has been used. It must not be forgotten that in club-feet, the irregularity of osteogenesis is frequently an important element in the deformity, and that in the course of growth the osteogenesis may continue to develop in the direction of an irregular deformity, in spite of care and in spite of apparatus. It may be frequently necessary to continue the care of club-feet which have been reduced by manipulation as late as the eighth year.

PERIOD OF RELATIVE REDUCTIBILITY

This problem arises in those children who have not been thoroughly cared for, or with whom the treatment by manipulation has been insufficient, for one reason or another. The foot is deformed and manipulation is insufficient to reduce the foot to a satisfactory position, that is to a position of hypercorrection, not only because the individual bones of the tarsus are still malformed, but also because the contraction of the tendons and muscles, as well as the ligaments of the articulations, have gradually become adapted to the new position of the parts, and resist correction. In this period it is necessary to perform sections of tendons and ligaments in order to allow the immediate and complete reduction. In this period with this deformity there may be used:

1. Section of the internal lateral ligament of the tibiotarsal articulation (operation devised by Nové-Josserand).

2. The operation of Phelps-Kirmisson, in which a section is made on the internal plantar surface of the foot, cutting muscles and ligaments which have become retracted by the adaptation to the position of the deformity.

3. Section of the tendo Achillis; the slight but excellent interference in this period, which interference might have been unfortunate at the beginning of the treatment of congenital equinovarus. Adams has maintained

this for a long time. The tenotomy of the tendon should not be performed, except as a finishing touch after the success of the manipulation for the correction of the varus. The reduction by these means is possible from the age of one to four years and sometimes later, but after this period in spite of section of ligaments and tendons and the use of apparatus, a relapse may occur.

In such cases, it is our opinion again that it is not necessarily the fault of the surgeon who has operated, or the fault of the mother who has had charge of applying the apparatus. Again we believe that the abnormal osteogenesis continues through the growing period, and exercises its injurious influence no matter how thoroughly the methods of treatment have been carried out.

PERIOD OF COMPLETE IRREDUCIBILITY

In case the complete correction of the foot has not been obtained and maintained in either of the two periods just described, the condition then exists in which the deformity cannot be corrected either by the section of the ligaments or tendons. The bones of the foot have obeyed the law first described by Delpech of Montpelier; this growth is retarded on the surfaces which are subjected to abnormal pressure and the growth is increased in those surfaces of the articulations which are not subjected to pressure except that which is normal to these joints.

The astragalus, for example, enlarges at the level of the prefibula wedge of Nélaton and the "barre" of Adams, and it no longer fits in the tibioperoneal mortise. At this time the club-foot can be properly termed inveterate club foot, and it is evident that at this time such a foot can only be corrected by surgical interference directed toward the bone. It is these surgical interferences which we now propose to consider.

BLIND INTERFERENCE (BLOODLESS)

The corrective force at this time cannot certainly bring about the modification in the shape of the foot, except by crushing the bones or by tearing the ligaments. These manipulations are, moreover, not possible except either with the aid of a wedge, which is definitely traumatizing, or by levers,—the levers of Bradford, or the club foot wrench of Thomas, which are but another kind of an enormous "griffe de serrurier".

What happens by the use of such force applied to change the shape of a foot is clearly evident. The photographs show this very well, and there is casually seen the evidence of shortening of the epiphyses of the fibula or the tibia, changes not to be wondered at. This tarsal crushing is a hybrid of surgery in orthopaedics. The blind operation proposes to make possible the manual remodeling of the foot by the crushing of the central bones of the tarsus. Or, if it is in the region of the short bones of the foot toward which it is directed, it is necessary to be particularly careful, for

it is exactly this central region from which there seems to extend an osteogenetic activity. The immediate results of this operation are bad on account of the violent reaction in this field which the operation provokes. The late results are deplorable because it compromises seriously the osteogenesis of the tarsal bones. This operation we have completely abandoned.

"Le désossement" of the tarsus is an expression used by Lucas-Championnière to characterize certain large resections, which are performed on adults but which we do not hesitate at all to condemn with children.

THE REGULAR PROCEDURES

They are the true procedures which the experienced surgeon should employ today in the treatment of the inveterate (obstinate) congenital club-foot. We can divide these into three groups:

1. The periastragloid excisions.
2. Astragalectomies.
3. Cuneiform tarsectomies.

THE PERIASTRAGALOID EXCISION

The reasons which seem to endorse these operations lie in the attempt to place the astragalus in good position between the tibia and fibula, which may be sufficient for a satisfactory correction.

It is this idea which induced Nélaton to advise the abrasion of the external surfaces of the astragalus, and the removal of the wedge in the prefibula region. Massart added to this the abrasion of the internal surfaces of the external malleolus. It is also this idea which must have inspired Whitman to do his operation of osteotomy of the malleolus which consists of opening the inferior surface of the tibioperoneal articulation, to make a diastasis which permits the astragalus to be replaced into a position of backward dislocation. We estimate that this procedure, even when successful, is insufficient to correct the club-foot, except in those rare cases of pure equinus. If proof is necessary for this, it can be found in the observations of these same surgeons. Nélaton completes his operation by resecting the head and neck of the astragalus, in order to complete the correction of the equinus, and then also resects the greater epiphysis of the calcaneous, in order to correct the varus. Massart, in order to accomplish the correction of supination, is obliged to cut the internal lateral ligament.

Again we say that not only is this bloody reposition of the astragalus in an inveterate club-foot an operation insufficient in itself, but it is in our opinion inadvisable, for it destroys more or less the tibiotarsal articulation. We must also consider that among the articulations of the foot, there is a kind of functional hierarchy. The mediotarsal and subastragaloid articulations are then "grande dames," the other articulations of the foot are the people of less importance, but above everything there is the

queen,—the tibiotarsal articulation. Our advice always to our students is "never disturb the queen". Eliminate the two others if it seems necessary; you will practically never make the mistake by blocking these in correct position, but never under any conditions block and never remove the tibiotarsal articulation, and for this reason: In order to walk with the tibiotarsal articulation stiffened, it is necessary to raise the head of the metatarsus in finishing the step; the individual raises himself, therefore, at that moment on the point of the foot from which results a definite limp. Moreover, this abnormal gait is the cause of fatigue, and more than that, of pain in the tibiotarsal region. To avoid this fatigue or pain, the subject employs a substitute. He carries the front of the foot to the outside, and walks presenting the internal border of the foot towards the front, a grave fault well known to all surgeons, who have cared for the wounded of the war, afflicted with the lesions of the posterior part of the foot.

ASTRAGALECTOMIES

The reason which suggests this procedure is probably the following: Instead of removing with difficulty the lateral surfaces of the astragalus, and enlarging the mortise between the tibia and fibula, it is simpler to entirely remove the astragalus. This is true if the center of the astragalus remaining should be a very small portion, and consequently, of very little or no use. This operation is useful in the club-foot in which the equinus dominates over the other distortions, for in this procedure, no reduction of the deformity is present, without a very considerable resection of the anterior part of the astragalus.

In regard to astragalectomy in general, it is possible to make a very definite criticism. It does not perfectly correct, in an inveterate club-foot, the deviation of the varus or the supination, neither the deformity of the varus in the metatarsus, which often accompanies it. It is hardly effective except against the equinus. If it is necessary to show this, it is sufficient to see what is done by Gross of Nancy, and Whitman of New York, both of whom have been the promoters of the astragalectomies. They complete their operation by a cuneiform calcaneocuboid resection. But all astragalectomies are not performed in the same manner. The astragalectomy of Chibret consists in moving the astragalus, and then allowing it to fall back directly on the calcaneous in the tibioperoneal mortise. Referring to the old comparison of Farabeuf, the tibiofibula mortise is a knight on horseback, on the calcaneous with a saddle interposed, which is the astragalus. If the calcaneous rotates on its axis, turning on its external side, which is the lesion constantly found in the equinovarus club-foot, you can then easily remove the saddle; the knight can ride only when the horse lies down on his flank. Considering then, the case most favorable for astragalectomy is when the equinus is predominant. The astragalus is enucleated in front of the tibiofibula mortise, carrying with it the calcaneous which is firmly attached to it. Raising then the astragalous

cushion, our knight will fall forward on the pommel, which is the calcaneous. In order to be well balanced, it is necessary for him to carry himself forward on his mount, as far as the pommel; it is necessary that the tibiofibula mortise be advanced forward in contact with the scaphoid.

It is to accomplish this that Whitman replaces the foot posteriorly. In order to allow a sufficient advance of the tibiofibula mortise, it is necessary for us frequently to cut away, with a very thin gouge, the tubercle of the scaphoid. The astragalectomy of Whitman with reposition of the foot is, therefore, superior to the simple astragalectomy, but as stated above, is not effectual against the twist of the foot. For this reason, we prefer certain other operations which we shall discuss.

CUNEIFORM TARSECTOMIES

The definite superiority of the preceding interferences lies in the fact that they do not in a practical way touch the tibiotarsal articulations and in any case do not compromise the function of this joint.

The operation most classic and most employed is the external dorsal cuneiform tarsectomy of Farabeuf, but which perhaps is not too well known. It removes a single block of bone, but the orientation of this block is such that it permits the correction of the equinovarus, and of the joining of the axis of the anterior part of the foot and the axis of the posterior part of the foot. There are two definite criticisms which may be made against this classic operation:

1. It considerably shortens the foot itself.
2. It does not correct altogether the supination.

We have used a number of times a cuneiform tarsectomy with transplant, inspired by the operation of Albee. On the external surface of the foot is removed a wedge of bone, the point of which does not pass beyond the middle line. At this level is done an internal osteotomy, according to the method of Phelps-Kirmisson. The fore part of the foot is then carried to the outside, and there is then placed as a graft the bone wedge, which has been removed from the outer border of the tarsus. This operation is not a particularly convenient one, for it is limited in its practicability for the reason that in the children the internal tarsectomy does not allow a sufficient opening of the foot to receive the cuneiform fragment as a transplant. Moreover, this form of tarsectomy, like the preceding one, only imperfectly corrects the supination.

It is in our opinion preferable to use the following operation, which has been performed several years in our clinic and with most satisfactory results.

DOUBLE CUNEIFORM TARSECTOMY IN THE PEAK OF TORSION

Our operation is based on the following facts:

1. A cuneiform tarsectomy in the mediotarsal level can, because of the relation of the head and the neck of the astragalus, correct perfectly

the equinus, and the angular deviation of the axis of the front foot on the axis of the back foot.

2. A cuneiform tarsectomy placed at the subastragaloid area can alone perfectly correct supination of the foot.

3. In carrying the cuneiform resection not only to the center of the small bones of the foot, but confined to the extremities near the level of the articulations, there is diminished in an enormous degree the difficulties of ultimate growth, since in such cases the centers of growth of the small bones have not been destroyed.

This operation then which we advise presents a definite analogy, in the point of view of technique, with the double arthrodesis of Ducroquet-Launay, the excellent operation which has given so great service in corrective surgery.

In place of performing the operation at the level of the two interlines which constitute the peak of the torsion, that is to say, the mediotarsal and the subastragaloid articulations, and in place of doing only a decortization of the adjacent bone surfaces, the mass of the bone is cut out in the same general manner as in the usual resection. The operation is performed in the same manner which we have advised in a double arthrodesis, described in "Précis clinique et opératoire de chirurgie infantile" as follows:

The wedge is cut out from three sides. The posterior reaches to the fibula, the inferior extends along the sole of the foot under the external malleolus, the anterior crosses the foot perpendicularly at the level of the mediotarsal joint, as far as the level of the tendon of the anterior tibial. This is isolated and the extensor and peroneal tendons drawn to one side. The mediotarsal joint is then opened, and the fore foot is forcibly flexed, and with a thin-bladed chisel, it is possible to remove the mass without using the mallet. The sides of the opening can then be so cut as to make a dorsal cuneiform wedge, which corrects equinus, while the external cuneiform wedge corrects the adduction of the fore foot. The subastragaloid area is then more exposed by curving the foot forcibly to the inside, and in this opening is cut a horizontal cuneiform piece with the base external, which corrects the supination.

The definite superiority of this operation over that of the tarsectomies in unique block consists in the fact that it is possible to estimate the value of the correction, in consideration of the anatomical form of the lesion. If the supination predominates, the tarsectomy of the subastragaloid region predominates, and that of the mediotarsal is minimized. If the adduction and the supination predominates, it is in the mediotarsal areas in which the cuneiform tarsectomy would be the most important. It becomes, therefore, possible to subordinate exactly the amount of resection to the type of deformity. It is an osteoplasty "on demand".

We consider that in this type of deformity, the double cuneiform resection performed at the peak of torsion represents progress in the treatment of congenital equinus club-foot, and that it should be substituted for all other procedures, in the inveterate forms of cases which present bony deformity.

SECONDARY DEFORMITY OF THE BONES OF THE LEG

It is not unusual to observe in the congenital equinovarus important changes in the position in the tibia, and changes in the relative position of the bones in the tibiofibula mortise. These are due either to a true torsion of the tibia or more often to a torsion of the two bones of the leg, the one in relation to the other. Exceptionally, this torsion occurs on the inside, in the feet of children who have walked on the back or on the external border of an extreme deformity.

More often this twist shows itself on the outside, and apparently influenced by an instinctive compensation of the joint, to evade the contact of the front of the feet coming one against the other in walking. This torsion might often be accentuated to the point where the external malleolus passes nearly to a position behind the astragalus.

Although rather rare,—in one out of ten cases,—the torsion following the axis of the bones of the leg needs to be corrected. It is in these cases that our method, "ostéo-synthèse," is particularly accepted.

The inferior level of the tibia is the place of choice for transverse osteotomy, one surface lies under the line of resection and one above. The direction of these two surfaces make between them an angle, placed toward the front, which is equivalent to the torsion which is found in the bones of the leg. The bone is, therefore, cut by a gigli saw between the two planes. A corrective rotation is then made which necessarily must follow the axis of the tibia. It is sufficient then to connect the ends of the two portions by a plate, in order to fix them immovably into the desired position.

One cannot insist too much on the technique of this temporary osteosynthesis of which we have already spoken many times.

Such are, at present, the directions which appear to be the most valuable in the treatment of congenital equinovarus club-foot.

CYST OF THE EXTERNAL SEMILUNAR CARTILAGE WITH REPORT OF A CASE

BY SAMUEL KLEINBERG, M.D., F.A.C.S., NEW YORK

So few cases of this condition have been reported that it appears worth while to record in detail one that recently occurred in my practice, particularly in view of the interesting pathological findings. About twenty cases of this lesion have been described, and although in many of these there has been an investigation into the pathogenesis of the tumor, there is, as yet, no unanimity of opinion. Allison and O'Connor[1] from their study conclude ". . . it is our belief that these cysts represent the end result of a degenerative process caused by an interference with the blood supply of the cartilage in this region, the exciting cause of which is a non-lacerating injury". On the other hand Fisher[2] in his excellent monograph on internal derangements of the knee states that " . . . there seems little doubt that these cysts are ganglia which originate between the peripheral surface of the external cartilage and the synovial membrane with which it is covered at this spot. Moreover, these ganglia are due to mucoid degeneration of the connective tissue at this spot in which the fibrocartilage of the periphery of the meniscus may participate". Fisher further asserts ". . . that evidence of invasion of the cartilage itself is usually slight".

These are opposite opinions by eminent writers. In my case I was able to study the relation of the tumor to the adjacent tissues and to remove the cyst and cartilage *en masse*, affording an opportunity of investigating the intimate connection between the cyst and the cartilage and particularly the transition from cartilage to tumor.

CASE REPORT

David R., 32 years old, was referred to me in August 1925 for a swelling on the outer side of the right knee. This swelling was noticed four or five years previously, but as it had caused no inconvenience little attention was paid to it. There was no history of any injury. For the past two months there had been much pain at the swollen area and stiffness of the knee, particularly in the morning. An examination showed a swelling about the size of a small pigeon's egg on the outer side of the right knee, at the level of the joint line and slightly in front of the external lateral ligament. The swelling was tense and very tender. A diagnosis of cyst of the external semilunar cartilage was made and operative removal advised. The patient, however, did not consent to an operation at that time.

Ten weeks later he returned stating that he had had increasing pain and difficulty in walking and that the swelling was growing. An x-ray examination was negative. The original diagnosis was adhered to and an operation agreed upon.

The operation was done on October 20, 1925. A four-inch vertical incision was made over the external aspect of the right knee directly over the tumor. The incision was extended through the deep fascia. The edges of the skin were retracted and the tumor became distinctly outlined. An oblique incision was then made in the

FIG. 1

Cyst of the external semilunar cartilage. The cyst is the darker area at the periphery of the middle of the cartilage. The parallel markings on the cartilage are due to the teeth of the instrument used to deliver it from the joint.

ligamentous structures extending from above downward and forward, parallel to the fibres of this tissue. A cross incision was added to permit ample exposure of the tumor. The synovial lining above the tumor was incised and the joint entered. The tumor was found to be part of the external semilunar cartilage and extending from the middle of it. By slight rotation of the leg the anterior horn of the external semilunar cartilage was brought into view and was cut. By careful dissection the front of the cartilage was detached from the transverse ligament and elevated with the tumor. By further dissection the rest of the cartilage was separated from the transverse ligament, the external lateral ligament and the tendon of the popliteus muscle. By rotating the leg it was possible to cut the posterior horn of the cartilage and the cartilage and tumor were delivered *en masse* from the knee joint. The wound was closed with several layers of sutures, and healed by primary union. The patient had a complete recovery and has had no relapse during the past year.

The specimen (Fig. 1) showed that the tumor was located at the middle of the cartilage and was definitely part of it. Even from the gross appearance one could be certain that the tumor was part of, had grown out from, and was not an addition to the cartilage. There was no line of cleavage or demarcation between the meniscus and the cyst and the transition from cartilage to cyst was gradual. In the photograph the tumor corresponds to the dark area. On sectioning the tumor it was found to be a multilocular cyst. There were numerous cavities varying in size and containing a light yellow gelatinous substance. The photograph of the cut section (Fig. 2) shows the arrangement of the cysts and their walls. The tumor tissue gradually blends with the cartilage. This arrangement is demonstrated especially well in the photographs (Figs. 2 and 3). The slides were examined and reported on by Dr. Goldzieher, pathologist of the United Israel Zion Hospital of Brooklyn. Dr. Goldzieher made a cross section through the tumor and cartilage to the free border,—that is, through the entire thickness of the meniscus. His report reads:

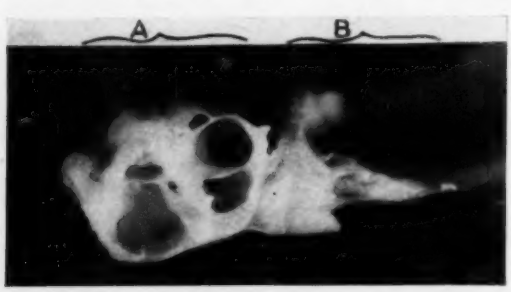


FIG. 2

Cross section of tumor and cartilage. The cyst formation is shown very well and also the intimate relation of the tumor and cartilage. A—Cyst. B—Cartilage.

"A large part of the cartilage, which grossly appears normal, shows necrosis. In this necrotic area there are many fissures or longitudinal defects (Fig. 3) in the cartilage. There are also many round holes (Fig. 4) of various sizes partly empty and partly filled with

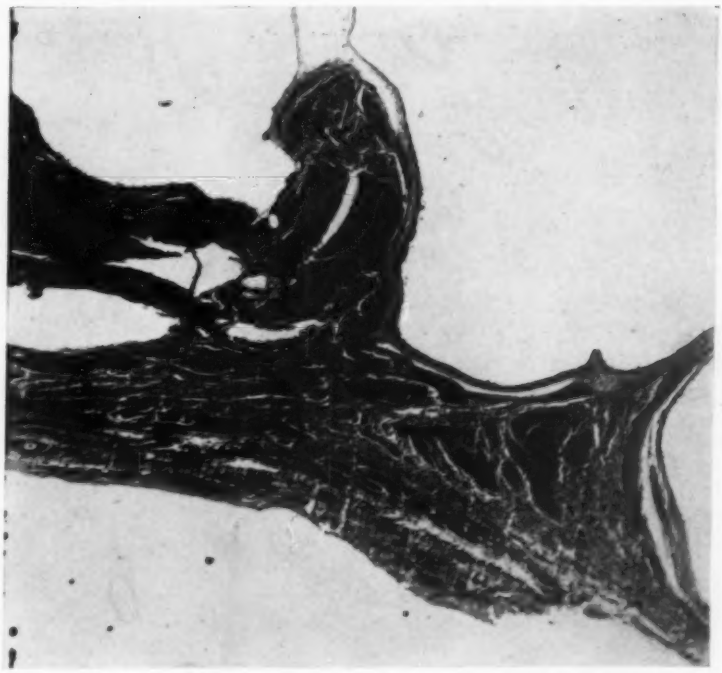


FIG. 3

Photomicrograph of a large section of the tumor. Very low power. Shows adjacent cysts and linear defects and vacuoles in the cartilage.

some apparently albuminous fluid. Similar changes are visible in those parts of the cartilage which are not necrotic, as demonstrated by the presence of properly stained nuclei.

"The larger cysts which can be seen grossly are formed by fibrous tissue. Their inner surface is lined with a layer of flat cells resembling endothelial cells and probably arising from the lymph vessels (Fig. 5). The nuclei are rod-shaped and the cytoplasm is scanty. Some of the cysts (Fig. 6) are separated from each other by septa which consist of a few connective tissue fibres and which are covered on both sides by the endothelium described above. There is no evidence of any inflammation.

"The cartilage is separated from the cysts by several layers of connective tissue. Nevertheless, it seems fair to assume that these larger cysts originated from the vacuoles in the cartilage, and the formation of an endothelial lining as well as that of a connective tissue wall are only secondary."

We are apparently dealing in this condition primarily with a lesion of the cartilage. Through some form of injury, or perhaps in some cases through a disturbance of the metabolism of the cartilage cells and without any injury, defects appear in the middle of the meniscus, the cartilage cells become necrotic, the defects become converted into vacuoles which coalesce, enlarge and become cysts. The cysts are lined by a layer of flat endothelial-like cells which Dr. Goldzieher suggests may arise from the lymph vessels. The cysts have a wall of thin fibrous tissue. This is presumably easily broken down, permitting the formation of larger cavities.

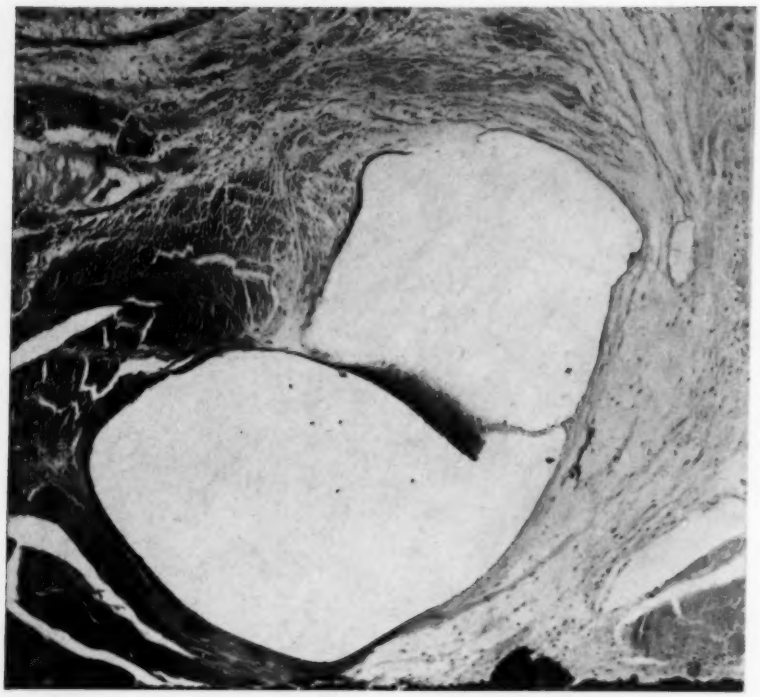


FIG. 4

Photomicrograph. Low power. Shows two of the smaller cysts within the solid portion of the cartilage.

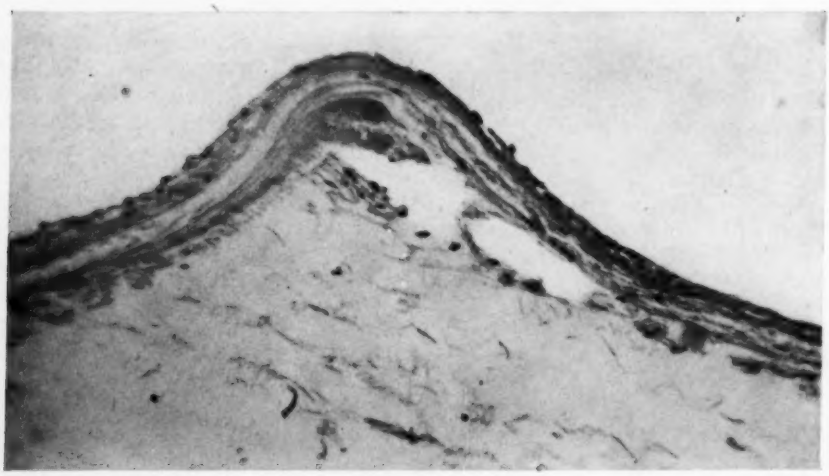


FIG. 5

High power photomicrograph showing the wall of one of the larger cysts covered with flat endothelial cells.

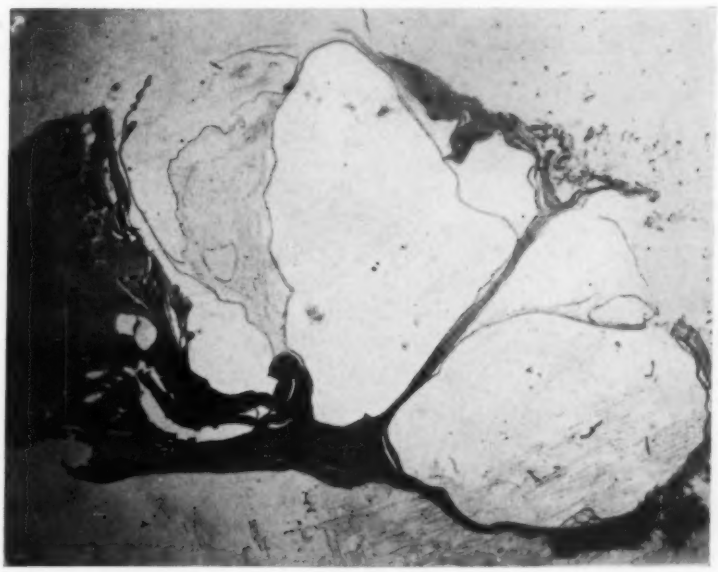


FIG. 6

Photomicrograph showing a part of the septum between several cysts. Low power.

From a study of this case and those in the literature I am convinced that the cysts arise from the cartilage and represent an end result of a degenerative process which begins in the cartilage. In this regard I am entirely in accord with Dr. Allison and opposed to Dr. Fisher's theory that the cyst is a ganglion resulting from a degeneration of the connective tissue at the outer border of the meniscus.

There are a number of interesting questions, however, which have not been answered and upon which I cannot throw any light. One, for instance, is the fact that it is always the middle of the cartilage which is affected. The lesion is always a multilocular cyst and practically never invades the internal meniscus. A history of injury is frequently obtained, but there is no very definite, unmistakable evidence of cause and effect, and frequently, as in this patient, there is no known trauma that could be connected with the tumor.

Cysts of the external semilunar cartilage of the knee occur infrequently. They are multilocular and arise from the cartilage as an end result of a degenerative process. There is no tendency to spontaneous disappearance, and complete removal, including the whole of the cartilage, is the only means of obtaining a complete cure.

1. ALLISON, N., and O'CONNOR, D.S.: Cysts of the Semilunar Cartilages. Surg. Gynec. Obst., XLII, 259, Feb., 1926.
2. FISHER, A. G. T.: Internal Derangements of the Knee. London, Oxford Medical Publications, 33–34, 1924.

LATERAL SUBASTRAGALOID DISLOCATION

Report of Case

BY H. D. SONNENSCHEIN, M.D., NEW YORK

The rarity of this condition prompts the writer to report the following case. Though it does not clearly fit into the classification of lateral subastragaloid luxations of the foot, as described by Jones, nevertheless I regarded it as such because of the separation of the subastragaloid articulation, the inward and downward rotation of the head of the astragalus with complete separation of the astragaloscaphoid joint and abduction of the forefoot.

CASE REPORT

J. L., male, aged 26.

Examination: Twenty-four hours after injury.

While coasting on a sled, January 28, 1926, patient's left foot struck some object in the snow; on account of the momentum there was no appreciable stop to the progress of the sled. The pain was knife-like in character. At the end of the trip the pain was intense, but patient was able to stand on his foot. The foot was so swollen that he could not remove shoe, which had to be cut away. Patient went home and applied wet dressings to foot all that night.

Fig. 1

Subastragaloid external dislocation with astragaloscaphoid dislocation.

Fig. 2

Subastragaloid external dislocation with astragaloscaphoid dislocation.

FIG. 3

Radiograph of foot nine months after operative reduction.

On examination the foot was markedly swollen and ecchymotic, the swelling and ecchymosis extending to the lower one-third of the leg. The forepart of the foot was in extreme abduction, the arch of the foot being completely obliterated, and the head of the astragalus could be palpated at the inner part of the sole of the foot. The heel was only in slight valgus as compared to forepart of foot. The entire foot was held in an equinus position. No motion was demonstrable at the ankle joint because of pain and swelling.

A diagnosis of dislocation of the astragalus was made, and the patient referred for x-ray.

X-ray findings: "The right astragalus is subluxated, so that the anterior extremity points downward and inward, anterior to the anterior end of the os calcis and internal to the scaphoid bone. The scaphoid is displaced upward and outward and there is a fracture at its angle which involves the astragaloscaphoid articulation. There is an incomplete horizontal linear fracture of the os calcis which runs backward for a distance of about one inch in the substance of this bone, through the astragalocalcaneal articulation. The cuboid is rotated downward and internally.

"As a result of the displacement of the astragalus, the lower end of the tibia (articular end) is displaced slightly downward."

Treatment: Under anaesthesia it was simple to replace the os calcis to its normal relationship and to partially replace the astragaloscaphoid articulation, but the entire deformity could not be overcome, even this partial reduction would recur immediately.

The astragalus being rotated on its longitudinal axis and tilted downward, it was impossible to replace and maintain by closed reduction.

FIG. 4

Radiograph of foot nine months after operative reduction.

FIG. 5
End result nine months after injury.

FIG. 6
End result nine months after injury.

Operation: Allowing ten days for the swelling and primary traumatic inflammation to subside, and using a similar approach as that described by Hoke for the foot reconstruction operation, an incision three and a half inches long was made on the outer side of foot, just below and behind the external malleolus, extending forward toward the head of the fourth metatarsal on the dorsum of the foot.

The astragaloscaphoid ligaments were found to be torn. A hook was placed around the neck of the astragalus, and with great difficulty the astragalus rotated into position, after which the astragaloscaphoid dislocation was completely reduced and maintained.

The subastragaloid dislocation was also reduced and maintained.

Because of the fractures of the cuboid and scaphoid bones and the ligamentous trauma, and the belief of the operator in arthrodesing tarsal fractures if the joint surfaces are involved, the astragaloscaphoid and calcaneocuboid joints were arthrodesed by removal of the articulating cartilages.

Plaster-of-Paris cast was applied from toes to knee while knee was in flexed position.

Postoperative treatment: After two weeks' time the cast was removed for inspection. Wounds had healed by primary union. Foot was in good position with firm union at site of arthrodeses. There was no swelling and motion was good at the ankle. Cast was replaced and worn until February 27, 1926. At that time there was fifteen degrees of motion in the ankle joint. Patient was walking with aid of a cane and wearing a shoe. Baking and massage were recommended.

On May 5, 1926, the patient resumed his work as a laborer.

End result: October 15, 1926. Nine months after injury.

Patient is now doing heavy work as a laborer and is on his feet nine hours each day. He apparently has no disability whatsoever; can walk, run and jump just as he could previous to the injury.

No limp can be detected in his gait. Both feet look exactly alike except for operative scar on right foot. Patient states that the only difference noticed is that before injury he wore a D width shoe but now has to wear an E width.

Flexion and extension at ankle are twenty-five degrees from a right angle. There is firm union at site of arthrodeses. Considered a perfect functional result.

END RESULTS OF ARTHROPLASTY OF THE HIP JOINT*

BY WILLIS C. CAMPBELL, M.D., MEMPHIS, TENN.

In compliance with the request of the Program Committee of the American Orthopaedic Association, the author submitted at the last meeting motion pictures, together with roentgenograms, before and after arthroplasty of the hip joint, as well as other data relative to results obtained from three to ten years after operation. As there prevails a considerable difference of opinion as to the durability and endurance of reconstructed joints, the object was to present for consideration of the Association, a body of expert surgeons, evidence of what end results had been accomplished in this field of surgery in this one joint. The results are considered in only those in which one hip was involved, as multiple or bilateral ankylosis presents a more complicated problem.

The value of operations for mobilization of ankylosed joints cannot be estimated for all joints collectively, for the operative technique in different joints varies, as does the anatomy and function complex. The results in even a single joint cannot be determined with accuracy and fairness, as the clinical aspect varies widely in ankylosis. For instance, the greater the length of time which has elapsed since ankylosis became established, the greater the muscle atrophy and the more difficult the restoration of muscle tone and joint function. The causative agent, the pathological process, and the position in which ankylosis occurs also obviously influence the result. Ankylosis with the hip in the anatomical position is by far more simple than when there is extensive contracture of the soft parts, with distortion and malposition. In fact, each individual case must be considered separately in concluding results until there has been a sufficient number of arthroplasties to classify different types. At present, however, the results can be considered only as secured in a single joint.

The pathology of ankylosis, the indications, operative technique, after-treatment, and literature of arthroplasty of the hip joint have been amply reviewed in former contributions, to which reference can be made. This discussion, therefore, will be confined to the end results and such factors as may have influence thereon.

Operations for mobilization of ankylosed joints are indicated at present only when the pathological process has been caused by either acute infection or trauma. Over ninety-five per cent. of ankylosed joints amenable to operation are caused by pyogenic organisms, as staphylococcus, streptococcus, pneumococcus and gonococcus, while trauma, uncomplicated by infection, is so rare as to be almost negligible. Operative measures for mobilization of single joints are contraindicated when

*Read before the American Orthopaedic Association at Atlanta, April 27, 1926.

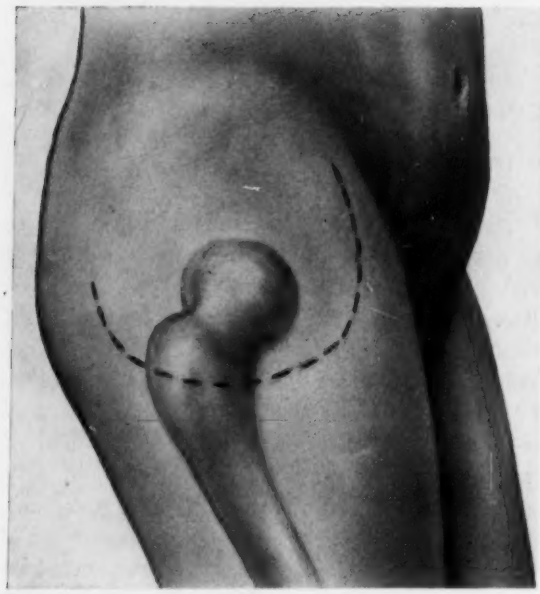


FIG. 1
Kocher skin incision for arthroplasty of the hip.
(By courtesy of *Surgery, Gynecology and Obstetrics.*)

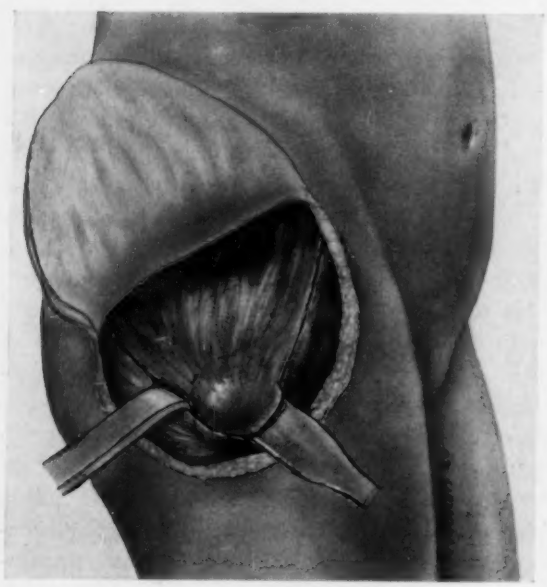


FIG. 2
Severance of the trochanter and large muscle flap.
(By courtesy of *Surgery, Gynecology and Obstetrics.*)

ankylosis is caused by tuberculosis. Arthroplasties for multiple ankylosis and various types of low grade progressive arthritis are in the experimental stage, therefore are excluded from the present discussion.

The counterpart of arthroplasty, as with many surgical procedures, is frequently induced from natural resources. A joint may be salvaged after extensive destruction by trauma or other pathological processes, as illustrated by the following three cases:

The first was a low grade destructive arthritis of the hip, probably tuberculous. The roentgenogram (Fig. 7) demonstrated that the head of the femur had been destroyed with erosion of the acetabulum, and yet the patient, a young woman, has almost normal function and walks with a scarcely perceptible limp. The second case, from the history and the appearance, as demonstrated by the roentgenogram (Fig. 8) was evidently the result of an acute pyogenic infection. This patient walks with very slight, if any limp, and

has about seventy-five per cent. normal range of motion. The roentgenogram indicates that the entire joint was probably destroyed by an acute infection. The third case was caused by a severe trauma, in which the head of the femur was crushed. The roentgenogram (Fig. 9) demonstrates a cone-shaped neck in an apparently normal acetabulum. The patient, a woman of fifty-five, walks with a very slight limp. In all these there is not only good function, but a fair degree of endurance.

As arthroplasty is so frequently confused with excision, a differentiation is necessary. Arthroplasty is the reconstruction of all the component parts of a joint, while excision is the resection of a mass of bone of sufficient dimension to insure pseudarthrosis.

The general impression prevails that the hip joint is more favorable for arthroplasty than the knee, which is probably based on theory and not substantiated by facts. Actual experience will demonstrate the reverse.

In estimating the end results of arthroplasty of the hip, there are four important requisites:

FIG. 3

Linear incision through capsule with complete separation from neck and head.
(By courtesy of *Surgery, Gynecology and Obstetrics.*)

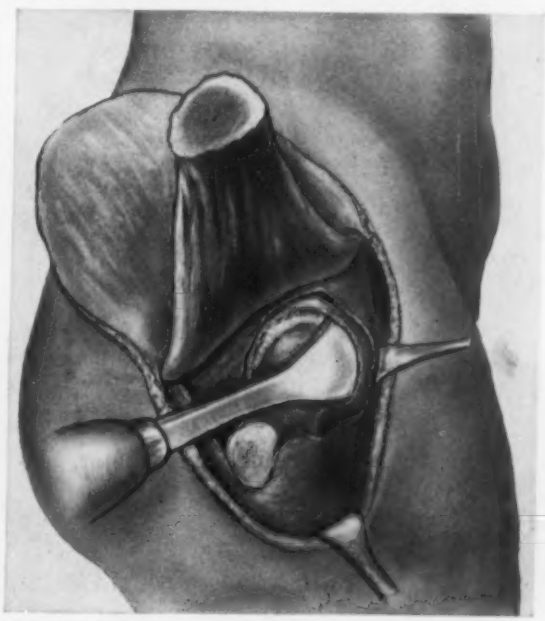


FIG. 4

Severance of bony fusion by wood carver's chisel.
(By courtesy of *Surgery, Gynecology and Obstetrics.*)

FIG. 5

Remodeled head and acetabulum.
(By courtesy of *Surgery, Gynecology and Obstetrics*.)

FIG. 6

Investment of acetabulum and head of femur with one continuous membrane of transplanted fascia lata, making a double fold between raw bony surfaces.
(By courtesy of *Surgery, Gynecology and Obstetrics*.)

(1) Function; by which is meant not only passive motion, but muscle power, or the ability to carry out active motion in various directions.

(2) Stability; the articulation should be stable, with a feeling of security.

(3) Endurance; the patient should be able to stand the strain of normal daily use.

(4) Durability; the joint must withstand the effect of time and remain serviceable throughout life. In the experience of the author, the result may be considered permanent after the lapse of two years, though a much larger number of cases must be observed over a longer period of time before definite conclusions can be reached. Unless the reproduced joints can conform to the above requirements, a stiff joint in the most useful position is more desirable.

In reviewing our records, sixty arthroplasties of the hip joint were found, but in only twenty-four of ankylosis of a single hip had a sufficient number of years elapsed since operation, and of these eight could not be traced. By far the largest percentage of the sixty were operated

on during the last five years, and in thirteen ankylosis was bilateral and therefore excluded. Only fifteen met the requirements of final analysis. Of these, ankylosis was caused in thirteen by acute pyogenic organisms, in one by trauma, and in one by tuberculosis. The end results are demonstrated in the following table.

As all important factors cannot be shown in the table, a brief record of the essential facts in each case will be reviewed.

FIG. 7

A counterpart of arthroplasty accomplished by nature after a destructive arthritis, probably tubercular.

CASE 1. February 15, 1916—Mr. J. W. B., age 23, single. The family history was negative. On August 9, 1915, during an acute Neisserian urethritis the patient had a sudden pain and swelling in the left wrist, and on the following day in the right hip. This was attended by high temperature, which persisted for weeks. He was in bed for six weeks and since that time his right hip had been stiff.

Examination:

Both limbs measured same length, but there was two inches practical shortening in the right hip. The right hip was flexed forty

FIG. 8

A counterpart of arthroplasty accomplished by nature after an acute infection destroying the articular surfaces.

FIG. 9

A counterpart of arthroplasty accomplished by nature after crushing of head of femur following excessive trauma.

FIG. 10

Case 1. Ten years after arthroplasty. Showing extensive proliferative changes but excellent functional result.

(By courtesy of *Surgery, Gynecology and Obstetrics.*)

degrees and adducted twenty degrees; ankylosis was complete The roentgenogram demonstrated bony fusion with normal bone structure.

Diagnosis: Bony ankylosis as a result of acute infectious arthritis of gonorrheal origin.

Operation: March 1, 1916; routine arthroplasty, as previously described; pedunculated fascial flap was inserted between the raw bony surfaces.

Result: Ten years after operation, active flexion to ninety degrees with knee extended. Active flexion with knee flexed about one hundred and twenty degrees; range in other directions practically normal. No atrophy; muscular development the same as in normal limb. Three-quarters of an inch shortening; walks with hardly perceptible limp. Endurance the same as in normal limb; can walk as far as previous to ankylosis.

Comment: Ankylosis had not existed a sufficient length of time to permanently impair muscle function, which accounts for the restoration to normal.

CASE 2. March 21, 1918—Miss M. H., age 25. Family history was negative. History of "rheumatism" all of life, with "bad attacks" every five years. For several years there had been a limp in the right hip. The teeth showed evidence of decay. There was a severe tonsillitis ten years previously, and dysmenorrhea and leucorrhea for past five years.

Examination: Right hip was flexed fifty degrees, adducted thirty degrees, with solid bony ankylosis. Both feet showed hallux valgus and claw toes. The roentgenogram showed solid bony fusion with no line of cleavage

between femur and ilium; bone structure of neck of femur and ilium continuous.

Diagnosis: From the x-rays, acute infectious arthritis, as history indefinite.

Operation: September 3, 1918; routine arthroplasty with interposition of pedunculated fascial flap.

Result: Seven years after operation, active flexion seventy degrees and about fifty per cent. of normal in other directions. Joint stable. Passive flexion to one hundred degrees and other movements in proportion. Atrophy apparent. Endurance satisfactory, but not so efficient as normal. However patient suffers with pain from clawtoes.

Comment: As ankylosis existed for an indefinite period, muscle power was not restored to normal, passive movement being greater than active. Nevertheless, the result is relatively excellent when compared to her former state.

CASE 3. December 19, 1917—Mrs. E. E. B., age 33, married eleven years, has four healthy children. Three years previously she had a chill and high fever with involvement of several joints, affecting more severely the right hip joint. Since that time the joint had been stiff. She had leucorrhea previous to the attack.

Examination: Solid bony ankylosis of the right hip. Flexed thirty degrees, adducted thirty degrees. No evidence of acute infection. X-ray demonstrated solid bony ankylosis, with destructive and proliferative changes.

Diagnosis: Acute infectious arthritis of unknown origin.

Operation: May 7, 1918; routine arthroplasty with interposition of pedunculated fascial flap between the articular surfaces.

Result: Eight years after operation, active and passive motion free, flexion sixty degrees, other movements about fifty per cent. of normal. Slight if any muscle atrophy. Muscle power and endurance normal; normal stability.

CASE 4. June 4, 1919—Mrs. S. G., age 21, married two years. Paternal uncles and aunts died of pulmonary tuberculosis. Past history negative except for leucorrhea and dysmenorrhea. Stuck nail in foot ten years previously; two days later had pain and swelling in left hip, since which time the hip had been stiff. Had slight abscess six months previously.

Examination: Left hip flexed thirty degrees and adducted thirty degrees, with solid bony ankylosis. No evidence of acute infection. The roentgenogram showed solid bony ankylosis with

FIG. 11

Case 3. Seven and one-half years after arthroplasty of hip. Showing extensive proliferative changes. There was excellent functional result.

no line of cleavage and continuous osseous structure between the femur and ilium. Evident acute infection.

Diagnosis: Acute infectious arthritis of unknown origin.

Operation: September 25, 1919; routine arthroplasty with interposition of chromicized pig bladder. Acute infection followed, with extrusion of membrane and draining sinus for one year.

Result: Failure, with probable fusion.

Comment: Irritation might have been caused by membrane, as a similar fate met several arthroplasties of other joints about the same time, though from the history, an acute process may have been relighted, as an abscess was present six months previously.

CASE 5. January 2, 1921—Miss A. B., age 26. In September, 1920, the patient fell from a horse, slipping on the right hip, after which she was in bed in plaster cast for six weeks. Since that time the right hip had been stiff and painful.

Examination: The right hip showed a decided limp in extreme external rotation. Ankylosis practically complete. Three-quarters of an inch shortening in right lower extremity. The roentgenogram showed a comminuted fracture of the right acetabulum and head of right femur.

Diagnosis: Bony ankylosis as a result of trauma.

Operation: March 3, 1921; routine arthroplasty. Head of femur was apparently driven partially through the acetabulum, and ankylosis was of solid bone.

Result: Five years after arthroplasty, observed through the kindness of Dr.

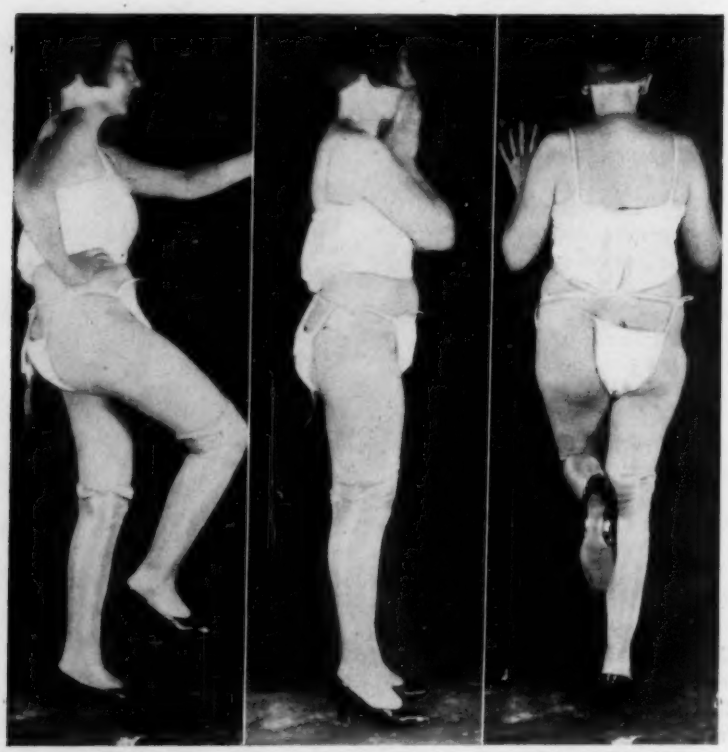


FIG. 12

Case 3. Sixty degrees flexion eight years after arthroplasty of hip.

FIG. 13

Case 3. Full extension eight years after arthroplasty of hip.

FIG. 14

Case 3. Standing on infected hip eight years after arthroplasty, showing pelvic balance; Trendelenburg's sign.

Frederick C. Kidner, as the patient now resides in Detroit. A letter from Dr. Kidner, dated April 3, 1922, states the patient has about sixty degrees flexion in hip; slightly adducted; good stability; no abduction; one inch shortening. Patient states in letter dated April 27, 1926, that she has some pain at times, but can walk as far as she desires. Motion pictures demonstrate the condition as stated by Dr. Kidner.

Comment: This is the only one of the series in which trauma was a factor, and the only one in which there was even a slight degree of adduction.

FIG. 15

Case 5. Showing end result five years after arthroplasty for bony ankylosis following trauma.

CASE 6. June 11, 1922—Miss E. P., age 18. In previous September (1921) had a slight pain in right hip. On the following day had chill and high fever, with severe pain and swelling of right hip. Left elbow, both knees and wrist became involved. In bed seventeen weeks. Movements in all joints except hip returned; hip at present stiff. History of Neisserian infection.

Examination: Complete bony ankylosis of right hip in forty-five degrees flexion. Slight flexion deformity of knee, with contracture of tendo Achillis. Atrophy of thigh muscles. The roentgenogram showed destructive changes in right hip, with the head of the femur almost destroyed and apparently fused with the acetabulum.

Diagnosis: Acute infectious arthritis (Neisserian).

Operation: June 12, 1922; routine arthroplasty of right hip with interposition of pedunculated pedicle flap. After operation patient complained of severe pain for several weeks in sciatic nerve but made uneventful recovery. One year later, lengthening of tendo Achillis for equinus.

Result: Two years after arthroplasty patient walks with definite limp, which is decreasing. Motion is free and easy and the joint is stable. Flexion ninety degrees with seventy-five per cent. of normal motion in other directions. As patient resides in Michigan, no observation could be made at present, but letter dated March 22, 1926, states, "I swim, dive and have hiked six miles at a time; average weight 135 pounds". This case is included, as personal observation was made one year ago and there is no reason to assume that conditions have changed.

Comment: Traumatic neuritis was induced in some measure at operation. Contraction of the tendo Achillis also complicated, but did not deter after-treatment. Further increase in function of the hip followed lengthening of the tendon.

CASE 7. August 31, 1922—Miss L. M., age 19. Family history and past history indefinite. At the age of eight injured right hip; this was followed by lameness, which persisted. At one time had abscess. History very indefinite.

Examination: Right hip flexed forty degrees, adduction twenty degrees; ankylosis complete. No evidence of pain or tenderness. The roentgenogram showed definite proliferative changes, but no indication of definite origin. Joint space narrow; feeble fusion.

FIG. 16

Case 6. Showing joint about two years after arthroplasty. Note nail to retain trochanter in place, which is unnecessary and not routinely employed.

FIG. 17

Case 7. Case with indefinite history, which proved to be tubercular hip. This type should not be operated upon.

Provisional Diagnosis: Probably acute infectious arthritis.

Operation: September 1, 1922; routine arthroplasty with interposition of pedunculated fascial flap. Bony ankylosis was complete, with obliteration of joint and suggestive of a previous acute pyogenic infection; no evidence of tuberculosis. In two weeks after operation, relighting of a definite infection, with draining sinus and the instigation of a typical tubercular joint of fungous type. Patient died at end of one year with acute miliary tuberculosis.

Comment: At the time of operation the diagnosis was doubtful, consequently especial care was taken to determine the pathology before proceeding with arthroplasty. We thought we were dealing with the results of acute pyogenic infection, but a tubercular infection prevailed and was relighted. Arthroplasty would not have been undertaken except through error in diagnosis.

CASE 8. January 12, 1920—Mrs. G. P., age 26. Patient was observed shortly after an acute pyogenic infection of the left hip, which was evidently of Neisserian origin. The hip was flexed eighty degrees, with extreme adduction and internal rotation, the correction of which required an open operation and arthrodesis of the hip. Three years later, March 1, 1923, the patient returned, having solid bony ankylosis.

Examination: Solid bony ankylosis with limb in anatomical position. The roentgenogram showed solid bony fusion of the left hip joint.

Diagnosis: Ankylosis as a result of acute pyogenic infection (Neisserian).

Operation: March 1, 1923; routine arthroplasty with interposition of pedunculated pedicle flap. Convalescence uneventful.

Results: Eighty degrees active flexion, with satisfactory motion in all directions; excellent. No comment.

CASE 9. May 14, 1923—Mr. H. R. R., age 30. In September, 1920, had had an acute pyogenic infection of the left hip, and had since walked with difficulty on account of severe deformity.

Examination: Solid bony ankylosis in extreme abduction; about thirty degrees flexion and external rotation.

Diagnosis: Bony ankylosis following acute pyogenic infection.

Operation: January 16, 1924; routine arthroplasty. Very difficult on account of position. A large amount of scar tissue was present and the hip was brought down to normal position with great difficulty after severance of bony fusion. Free fascia lata transplant interposed. On the following morning there was complete paralysis of the leg muscles, which has continued to the present time. An exploration was repeatedly offered but persistently refused.

Comment: Whether the nerve was severed or injured in bringing the hip down cannot be determined.

CASE 10. August 24, 1923—Mr. W. C. W., age 30. Ten years previously had acute pyogenic infection of the left hip, since which time the hip had been stiff.

Examination: Left hip flexed about thirty degrees, adducted thirty degrees, with about ten degrees painful motion. The pre-operative roentgenogram showed a destructive arthritis with proliferative changes and a narrow joint space; evidently fibrous ankylosis.

Diagnosis: Fibrous ankylosis following acute pyogenic infection.

Operation: September 18, 1923; routine arthroplasty with free fascia lata transplant. Convalescence was uneventful for three months. The roentgenogram then revealed a pathological fracture of the head of the femur, with marked osteoporosis.

Result: At the end of two years the head has been practically absorbed, but the trochanter and neck remain within the acetabulum and there is about seventy degrees free motion. The patient walks with a very definite limp, resembling the results of a reconstruction operation.

Comment: The pathological fracture was evidently due to osteoporosis, a factor which has frequently been emphasized. However, a better end result was secured than might have been expected under the circumstances.

CASE 11. October 11, 1923—Mr. R. W. J., age 27. In 1910, patient fell while playing basket ball, injuring

FIG. 18

Case 10. Pathological fracture from extensive osteoporosis, but good movable joint two years after arthroplasty of hip.

left hip, which he thought was dislocated. Was in bed with extension for seven weeks and walked on crutches for six weeks. Since that time had no disability until just previous to our observation, when hip had become gradually stiff and painful.

Examination: Walked with slight limp; marked crepitation on passive motion; flexion possible to ninety degrees; abduction twenty degrees. The roentgenogram showed destructive arthritis of the left hip with hypertrophic changes and apparent bony ankylosis.

Diagnosis: Traumatic arthritis following definite injury. No ankylosis but limited motion.

Operation: January 7, 1924; routine incision for arthroplasty. Acetabulum was found covered with apparently normal cartilage, but the head of the femur was irregular and hypertrophic. The head of the femur was trimmed down to smaller than normal and replaced within the acetabulum, but no tissue was interposed, as the encrusting cartilage of the acetabulum was regarded as sufficient. Recovery was uneventful, but ankylosis was apparent at the end of two months and again at the end of six months; consequently, this case was regarded as a failure. A more recent examination has proved otherwise.

Result: February 9, 1926, patient walked with slight limp with about forty degrees free motion, which he stated was increasing; pain and disability had been relieved.

Comment: This case illustrates a fact often observed after arthroplasty. A recurrence of ankylosis may be apparent after two or more months, but does not necessarily indicate failure, as motion may later develop. This condition is probably due to tissue reaction from passive motion. A number of arthroplasties have been classed as failures which were found later to be successful. No material was interposed between the articular surfaces in this case, which may account for a poorer result than might have been expected.

FIG. 19

Case 12. Eighteen months after arthroplasty of hip. In this case it was necessary to remove a larger portion of the head than usual on account of old abscess cavity. Good functional result.

(By courtesy of *Surgery, Gynecology and Obstetrics.*)

CASE 12. August 6, 1924—Miss G. K., age 22. One year previously had acute pyogenic infection in left hip, probably of Neisserian origin; since that time ankylosis had occurred.

Examination: Left hip flexed thirty degrees, with slight adduction; no motion demonstrated. Roentgenogram showed destructive change of an acute infection, with beginning bony fusion.

Diagnosis: Bony ankylosis of the left hip as a result of an acute pyogenic infection (Neisserian).

Operation: November 21, 1924; routine arthroplasty with interposition of free fascia lata transplant, as described in former contributions.

Result: Eighteen months after operation, ninety degrees free motion, stability, with increasing endurance. No comment.

CASE 13. October 18, 1924—Miss O. D., age 19. Gave a history of an acute infection of the right hip in November, 1923. Since that time the joint had been stiff and in malposition.

Examination: Right hip fixed at forty-five degrees flexion and forty-five degrees outward rotation. No motion demonstrable. The roentgenogram showed destructive and proliferative arthritis, with apparent bony fusion beginning.

Diagnosis: Bony ankylosis as a result of acute pyogenic infection.

Operation: October 20, 1924; routine arthroplasty with interposition of free fascia lata transplant investing head of femur and acetabulum.

Result: Eighty degrees flexion with increasing endurance. No comment.

CASE 14. October 25, 1924—Miss E. G., age 26, nurse. In 1920, had an acute pyogenic infection of the left hip, since which time the left hip had been stiff.

Examination: Left hip had firm ankylosis in anatomical position; no tenderness. The roentgenogram showed destructive arthritis of the left hip, with apparently solid bony union.

Diagnosis: Solid bony ankylosis as a result of an acute pyogenic infection.

Operation: October 27, 1924; routine arthroplasty with interposition of free fascia lata transplant. Recovery uneventful. About thirty degrees free motion was present at end of eight weeks, when patient returned home. Physiotherapy for two months after operation.

Result: Roentgenograms made under the direction of Dr. Robert Schauffler, of Kansas City, demonstrate gradual disintegration of the head and neck of the femur, which is probably an osteoporosis. At the end of one year after arthroplasty, an abscess formed, which was opened and drained. Motion has materially increased. The result is doubtful and probably a failure.

Comment: Osteoporosis, or bone atrophy, is a contributing factor. The abscess was probably a relighting of an acute infection, which is not infrequently observed after any acute pyogenic process in bone. The end result will probably be similar to a reconstruction operation for non-union of fracture of the neck of the femur, as demonstrated in Case 10.

FIG. 20

Case 14. One month after arthroplasty showing well formed joint. Note condition one year later.

FIG. 21

Case 14. Osteoporosis with pathological fracture, as noted one year after arthroplasty. Fracture probably due to osteoporosis.

CASE 15. January 21, 1925—Mr. R. C. C., age 16. Definite history of an acute pyogenic infection of the left hip at age of twelve, since which time the left hip had been stiff.

Examination: Left hip showed firm ankylosis in thirty degrees flexion, with twenty degrees abduction and external rotation. The roentgenogram showed destructive arthritis with proliferative changes, suggesting a previous pyogenic infection and solid bony ankylosis.

Diagnosis: Solid bony ankylosis caused by an acute pyogenic infection of unknown origin.

Operation: January 8, 1925; routine arthroplasty with interposition of free fascia lata transplant.

Result: Sixty degrees motion at end of fifteen months, with increase in range and function. Endurance and stability excellent.

Comment: Apparently excellent result, as there has been no retrograde change in the experience of the author after the lapse of one year.

There were four cases with complications which should be elucidated: Case 4 had an infection with extrusion of especially prepared animal membrane which had been interposed. This material was found later to be defective, as three other joints operated upon at the same time were similarly affected. In consequence, all foreign material has been discarded as a substance for interposition in arthroplasties. Case 7 had a relighting of an old tuberculous infection, with death one year later as a result of miliary tuberculosis. Arthroplasty would not have been employed except for error in diagnosis as to causative agent. No accurate history was available and the roentgenogram was doubtful. In Case 6, there was neuritis with drop-foot, which persisted for several months with gradual and complete recovery. In Case 9 there was a persistent neuritis and paralysis, and after the lapse of six months from the time of operation an exploratory operation was repeatedly urged and refused. In this man there was ankylosis in extreme abduction, the reduction of which must have caused trauma to the sciatic nerve, though care was taken to avoid undue stress by severance of contracted tissues and the excision of sufficient bone.

In two cases there was osteoporosis with disintegration and absorption

ARTHROPLASTIES OF THE HIP WITH UNILATERAL ANKYLOSIS

Name	*Sex*	*Age*	*Date of Operation*	*Complications*	*Degree of Motion*	*Stability*	*Endurance*	*Result*
Case 1	M	21	3/1/16	None	120	Excellent	Excellent	Excellent
Case 2	F	25	9/3/18	None	80	Excellent	Excellent	Excellent
Case 3	F	33	5/7/18	None	60	Excellent	Excellent	Excellent
Case 4	F	21	9/25/19	Infection	None	.....	.....	Recurred
Case 5	F	26	3/3/21	None	90	Excellent	Excellent	Excellent
Case 6	F	18	6/12/22	Neuritis	90	Excellent	Excellent	Excellent
Case 7	F	19	9/1/22	Infection	...	.....	.....	Died—T.B.
Case 8	F	26	3/1/23	None	80	Excellent	Excellent	Excellent
Case 9	M	30	1/16/24	Nerve injury	None	.....	.....	Recurred
Case 10	M	30	9/18/23	Osteoporosis	70	Doubtful	Doubtful	Fair
Case 11	M	27	1/7/24	None	50	Excellent	Excellent	Excellent
Case 12	F	22	11/21/24	None	90	Excellent	Excellent	Excellent
Case 13	F	19	10/20/24	None	80	Excellent	Excellent	Excellent
Case 14	F	26	10/27/24	Osteoporosis	80	Doubtful	Doubtful	Doubtful
Case 15	M	16	1/8/25	None	60	Excellent	Excellent	Excellent

of the head, but no displacement. In one of these patients, who was referred by Dr. Robert Schauffler and Dr. Clarence B. Francisco, of Kansas City, an abscess occurred one year after operation. This was probably due to relighting of the same infection that caused the ankylosis, as there was primary healing with no evidence of infection after the arthroplasty. In both cases with osteoporosis there is good motion, but time alone will determine the degree of efficiency. Both closely resemble the results of a reconstruction operation for ununited fracture of the neck of the femur.

Of the fifteen arthroplasties for ankylosis of one hip, eleven were in women and only five in men; all were in young adults from sixteen to thirty-five years of age, which is the period of life more favorable for arthroplasty.

Of the fifteen patients, there have been excellent results in ten, fair in one, doubtful in one. There have been no operative deaths, but one died one year later, and death must be attributed to operation. In only two has ankylosis recurred. Of the ten with excellent results, ankylosis was probably caused in five by the gonococcus, which apparently refutes the statement that ankylosis caused by gonorrheal arthritis contraindicates arthroplasty.

Of the ten apparently excellent results, sufficient time has elapsed in six to conclude as to durability, which are, respectively, 10 years, 8½ years, 7½ years, 5 years, 3½ years and 3 years. In all there is stability, endurance and efficiency, which, after all, is the acid test. After the lapse of three years a more comprehensive report can be made on a much larger series.

SURGICAL TREATMENT OF TRAUMATIC SPONDYLOLISTHESIS

BY JOHN C. WILSON, M.D., LOS ANGELES, CALIFORNIA

INTRODUCTION

Careful study of those suffering from injuries to the low back has demonstrated the unsuspected frequency of spondylolisthesis. The term means displacement of one vertebra upon another and has dogmatically been limited to anterior dislocations of the fifth lumbar upon the sacrum. The fourth lumbar vertebra may be displaced anteriorly upon the fifth in very much the same manner that the fifth is dislocated upon the sacrum, as will be shown in one of our cases; therefore it seems best to include forward displacement of the fourth lumbar upon the fifth in the classification.

The spondylolisthetic pelvis has long held a prominent place in obstetrical writings but only recently has the true orthopaedic importance of spondylolisthesis been recognized. A review of the literature does not offer suggestions based upon a sufficient number of cases to justify any definite recommendations for treatment.

Jones and Lovett in a recent textbook on Orthopaedic Surgery give a brief but rather comprehensive description of the subject. Turner and Tchirkin in a contribution to *The Journal of Bone and Joint Surgery* review the literature and while having ten cases at their disposal report in detail only six of unquestioned diagnosis. The subject is dismissed with the conclusion that operative measures are of doubtful value.

Due credit must be extended to the roentgenologists for the demonstration of many pathologic structural changes of the sacrolumbar region which have long been concealed. Although preceded a few years by Darling and George, Bowman in 1923 before The American Roentgen Ray Society first presented this subject in detail from the roentgenologic view-point, directing attention to forward displacement of the body of the vertebra and deviation of the line of the neural canal as seen in the lateral roentgenogram.

ANATOMY

The lumbosacral joint forms the point of inferior contact between flexible and fixed spinal segments. The fifth lumbar vertebra differs only in that the vertical diameter of the body is greater in front than behind; the transverse processes are short, thick and wedge-shaped; the superior articular processes are directed more backward and the inferior articular processes are directed more forward than those of the other lumbar vertebrae. The position of the articular facets is not always uniform. The mechanical inefficiency due to the obliquity of the anteroposterior axis of the vertebra is compensated for to a degree by the strong iliolumbar ligaments and the thickness of the sacrolumbar intervertebral disc.

PATHOLOGIC ANATOMY

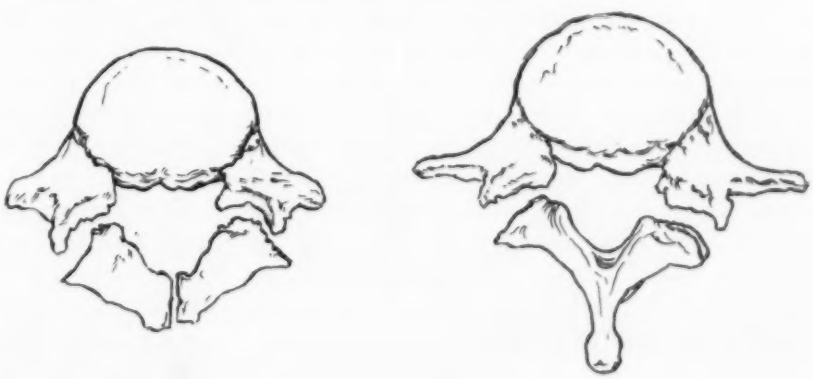
Certain anatomic variations were present in the cases studied, which seem to have been factors in the formation of mechanically imperfect articulations:

1. Incomplete neural arch.
2. Bilateral laminar defects.
3. Asymmetrical articular facets.
4. Increased obliquity of the articular facets.

It is generally agreed that complete unlocking of the lumbosacral facets does not take place. Rather striking abnormal mobility in the anteroposterior plane of the neural arch was demonstrated at the time of operation in our cases without apparent separation of the posterior articular lumbar and sacral facets.

One case exhibited a fracture of the posterior articular process of the third lumbar vertebra on the right side which was unrecognized prior to the time of operation. In one instance the neural arch had separated between the posterior, superior and inferior articular facets so that it could have been entirely removed.

Separation of the neural arch of the fifth lumbar vertebra was found, by Willis, in 4.8 per cent. of 850 spinal columns. This has been attributed to incomplete ossification by Neugebauer, while Poirier is of the opinion that the mechanical strain causes a giving away, because of upright posture. Demonstration of fibrocartilaginous areas in the arch, by Willis, offers the most plausible explanation of anterior displacement of the vertebral body. Abnormal mobility of the neural arch has been demonstrated to our satisfaction upon the living subject with the posterior lumbosacral facets in their normal relationship and the vertebral body displaced forward, as shown by roentgenograms; therefore, a giving way between the dorsal and ventral vertebral segments must have taken place.



A B

FIG. 1

A. Complete separation of the neural arch with a bifid spine.

B. Complete separation of the neural arch.

Tracings from photographs of anatomical specimens. T. A. Willis, American Journal of Anatomy.

The cases studied, with two exceptions, were due undoubtedly to severe trauma. One may be explained by Lane's theory of prolonged physiological strain, while another is believed to be of gradual development because of a heavy sack carried in front of the body by a supporting cord about the waist.

The application of the force was essentially the same in the traumatic cases, parallel to the longitudinal axis of the ovoid with one or both thighs flexed at the hip. It is believed that forcible extension of the spine at the time of application of the force may be an accessory factor.

Separation of the neural arch between the superior and inferior articular processes may allow some encroachment upon the size, or variation of shape of the intervertebral foramen, which in case of the fifth lumbar is almost certain to give symptoms because of the slight difference in diameter between the canal and nerve root. Relief from symptoms upon fixation of the neural arch would lead us to believe that the position of the body is of little practical importance.

CLINICAL SYMPTOMS

Back pain localized by the patient at the lumbosacral angle was a constant complaint. Leg pain with a definite distribution was not as frequent as would be expected. The cases studied described the leg discomfort as a dull ache rather than in a manner commonly classified as sciatica. Limited motion with increasing stiffness on attempted exercise was a source of great discomfort. None of our patients gave a history of a slipping sensation at the time of injury. Not one of the cases gave subjective or objective evidence of motor or sensory paralysis. All were totally disabled because of back weakness, stiffness and pain.

PHYSICAL SIGNS

The shortening of the lumbar segment of the spine, acute lumbosacral angle and lumbar lordosis which go to make up the classical picture of spondylolisthesis were not present to any great degree in the cases studied.

These patients, with but one exception, exhibited all of the cardinal symptoms of lumbosacral inflammation: flat backs; bilateral muscle spasm; limitation of motion, particularly extension, and marked hamstring spasm during the straight leg test when stress was brought upon the lumbar spine. The limitation of motion in the lumbar spine was constant in either the standing, sitting or recumbent position. There were no changes in the superficial or deep reflexes of the lower extremities. Tenderness was localized over the sacrolumbar joint.

ROENTGENOLOGIC EXAMINATION

Spondylolisthesis cannot be conclusively demonstrated without the assistance of the roentgen ray. The clinical history and examination give only evidence of a lumbosacral lesion. A positive opinion based on an anteroposterior roentgenogram is of doubtful significance. True lateral

roentgenologic examination offers the only safe guide to the relationship of vertebrae to each other.

The presence of the shadow of the vertebral body anteriorly to the sacrum is pointed out by Darling as furnishing suggestive evidence of spondylolisthesis. However, this must be corroborated by a true lateral roentgenogram which, if the dislocation is gross, leaves no doubt as to the diagnosis. This must reveal definite forward displacement of the vertebral body with a break in the line of the neural canal.

TREATMENT

A joint which has been dislocated partially or completely must be reduced or fixed before any degree of function is to be expected. Assuming these facts to be true, two possibilities in treatment become apparent;—namely reduction or fixation. Fixation of a displaced vertebra by apparatus, hoping for sufficient consolidation to alleviate symptoms, is hardly a sound surgical principle.

At least one and in several instances two attempts were made to replace the vertebrae. The displacement of the fourth lumbar vertebra on the fifth was corrected, but this must be considered purely accidental for it occurred during examination and neither the patient nor the examiner were aware of any change in the alignment of the vertebrae. The immediate cessation of excruciating perineal and rectal pain aroused suspicion and a subsequent lateral roentgenogram indicated the disappearance of the spondylolisthesis. Pelvic traction with head countertraction were used both immediately before attempted reduction and for a fourteen-day period prior to manipulation. Roentgenograms did not show the least change in the position of the fifth lumbar vertebra.

Failing to reduce these displacements and realizing the hopelessness of attempting to restore these patients to a state of usefulness by conservative treatment, fixation in the position of displacement seemed to be the next logical step.

Lumbosacral fusion (Hibbs') offers few technical difficulties and gives complete fixation in due time, so should be the method of choice.

This procedure may be modified to the extent of repairing the defect in the neural arch by using the spinous processes of the third and fourth lumbar vertebrae as grafts (Case 4).

The lumbosacral facets are easily exposed and denuded. After the ligamentum subflava between the fifth lumbar and first sacral vertebrae has been carefully excised and the body of the sacrum exposed, liberal osteoplastic flaps are reflected up over the denuded laminae of the fifth lumbar vertebra.

It is believed that fusion of the fifth lumbar vertebra to the sacrum is sufficient unless there is definite evidence of displacement of the fourth with locking of its spinous process with the fifth lumbar vertebra as was found in Case 1. In this instance it seemed safer to fuse the fourth lumbar vertebra to the fifth and first sacral segment. The operation should be

followed by three to four months of recumbency on a Bradford frame or on a hard bed with the patient wearing a Taylor back brace.

This method was used in four cases, three making an uninterrupted postoperative recovery and one developing a severe haemolytic streptococcus infection in the superficial tissues of the operative wound. Although this patient was very ill for twenty-one days, immediate removal of the skin sutures prevented deep extension of the infection and the patient proceeded to a satisfactory recovery.

More than a year and a half has elapsed since the last of these operations was done and all these patients are free from apparatus and symptoms. Three men have returned to hard labor, one in the penitentiary and the others in civil life. The fourth, a woman, does her housework without discomfort.

Two additional patients have been operated upon with a modification of the Hibbs' technique in that lateral autogenous bone grafts have been placed in contact with the spinous processes of the fourth and fifth lumbar vertebrae and the first sacral vertebra. These patients were operated upon too recently to give definite evidence of the result. This reenforcement with lateral grafts seems superfluous but was felt by one of our operators to give added support.

This discussion represents an exhaustive study of nine indisputable cases of spondylolisthesis; eight adults and one child. Six of the adults were males and two were females. The child was a female. Of the adult cases six were treated by operative fusion, one was reduced by manipulation and two were untreated.

CASE 1. Male. Age, 20 years. Laborer.

Admitted to Los Angeles General Hospital on October 13, 1924.

Complaint: Backache extending down both legs.

Clinical History: The onset of the pain has been gradual during the past year. One year ago the patient was employed as a walnut picker. This necessitated carrying a bag suspended by a rope from the waist which when filled weighed 125 lbs. The patient believes that this is responsible for his disability.

Physical Examination: The patient is a well developed young Mexican male. There is definite bilateral lumbosacral muscle spasm. All movements of the spine are restricted both in the standing and lying positions. Straight leg lifting is limited when stress is brought upon the lumbar spine. The spinous process of the fifth lumbar vertebra is depressed. Tenderness is marked and localized at the lumbosacral articulations.

Roentgenologic Examination: Roentgenograms reveal marked forward displacement of the fifth lumbar vertebra upon the sacrum. The neural arch has failed to fuse.

Operation: Fusion, October 23, 1924.

Surgical Pathology: Rotation of the fifth lumbar vertebra has caused locking of the spinous processes of the fourth and fifth lumbar vertebrae. The fifth lumbar vertebra was so displaced forward that the normal contact did not exist between the lumbar and sacral articular facets. The fifth lumbar vertebra was abnormally mobile, allowing a considerable degree of motion in the anteroposterior plane when held with grasping forceps. The segments of the neural arch present were very hard, flaps being turned up only after great difficulty. The fourth and fifth lumbar vertebrae and first sacral vertebra were fused.

The patient remained in bed on a Bradford frame until January 28, 1925, when he was fitted with a back brace and allowed to be up. Lumbar motion is restricted but not painful.

June 10, 1925—The patient has no pain in the back or legs. No movement of the spine occurs below the third lumbar vertebra. Straight leg lifting is free and not painful.

November 1, 1925—The patient has been without his brace for four months. No complaints of pain or stiffness in the back are offered, even though he has been engaged in hard labor. Roentgenologic examination demonstrates complete consolidation of the fusion. This patient was discharged as cured.

Case 2. Female. Age, 65 years.

Admitted to Los Angeles General Hospital on August 4, 1924.

Complaint: Severe pain localized in the low back.

Clinical History: Early in February, 1924, while lifting one end of a trunk the entire weight was suddenly thrown upon her handle of the trunk, causing a sudden wrenching of the back accompanied by sharp pain in the lumbosacral region and a snap which was audible to others standing about. The patient fell to the floor and was not able to arise without aid. She remained in bed for two months and then attempted to get about, but found walking practically impossible because of pain in the back. A diagnosis of spondylolisthesis had been made and after twenty-one days of head and pelvic traction, reduction under anaesthesia had been attempted without success.

Physical Examination: The patient is a heavy female apparently well beyond sixty years of age. The upper dorsal curve is exaggerated and the lumbar segment of the spine is flat. She moves about as though in great discomfort. All movements of the spine in both the sitting and standing position are limited. Muscle spasm is noted in the lumbar region. Straight leg lifting and thigh flexion cause pain when the lumbar spine is strained.

Roentgenologic Examination: Roentgenograms give positive evidence of spondylolisthesis.

August 5, 1924—Under anaesthesia an attempt was made to reduce the deformity.

August 6, 1924—X-ray examination showed no change in the position of the body of the fifth lumbar vertebra.

Operation: August 8, 1924—A lumbosacral fusion.

Surgical Pathology: The posterior articular process of the fifth lumbar vertebra on the right side had been fractured and rotated so that it was not in proper contact with the sacral facet. Movement of the fifth lumbar vertebra in the anteroposterior plane was marked. The fifth lumbar vertebra and the first sacral segment were fused.

September 1, 1924—A severe haemolytic streptococcus infection developed in the wound. The skin stitches were removed.

November 14, 1924—After a stormy convalescence the wound has now healed. Apparently the infection did not extend below the deep fascia.

December 11, 1924—The patient is up and about, complaining of some discomfort in the back. A rigid back brace is being worn. Movements of the lumbar spine are guarded. Some lumbosacral tenderness persists. The patient was discharged.

March 4, 1925—The backache has disappeared. Some lumbosacral stiffness persists.

November 1, 1925—The apparatus has been discarded for one month. All movements of the spine are as free as would be expected in a woman sixty-five years of age. In the absence of symptoms and positive physical signs, with x-ray evidence of good lumbosacral consolidation, the patient was discharged as cured.

Case 3. Male. Age, 23 years. Laborer.

Admitted to the Los Angeles General Hospital on July 15, 1924.

Complaint: Constant pain in the low back, made worse by walking or standing.

Clinical History: The patient states that the pain in his back began about six months prior to his entry into this hospital. He has been doing a great deal of heavy lifting and although he is not sure when his back was injured he feels that this has been a factor in causing his discomfort. At the present time he receives no relief from recumbency.

Physical Examination: Lumbar muscle spasm is marked. All movements of the lumbar spine are restricted. Straight leg lifting is painful when the lumbar spine is

strained. There is definite tenderness at the level of the lumbosacral articulation. There are no appreciable changes in the normal contour of the back.

Roentgenologic Examination: Roentgenograms reveal definite forward displacement of the body of the fifth lumbar vertebra. The laminae of the first sacral segment have failed to fuse.

Operation: August 17, 1924—A spinal fusion was done.

Surgical Pathology: The neural arch of the first sacral segment is incomplete. The defect is in the right side. The spinous process is small and attached to the left lamina. The sacrolumbar articulation showed definite abnormal mobility in the anteroposterior axis. The spinous process of the fifth lumbar vertebra is very small and was found to be lying directly against the spinous process of the fourth lumbar vertebra. The fusion was done in the usual manner except that the sacral neural arch defect was repaired by osteoplastic sacral grafts.

November 11, 1924—The patient has made an uneventful recovery.

December 1, 1924—The patient was supplied with a back brace. He is up and about with no pain in the back. Forward, backward and lateral bending are somewhat restricted but not painful.

October 2, 1925—The patient has been without his back brace for three months. He has returned to his regular occupation and has no discomfort in his back. There is no appreciable restriction of motion. The patient was discharged as cured.

Case 4. Male. Age, 40 years.

Admitted to the Los Angeles General Hospital on August 23, 1924.

Complaint: Pain in the back, localized in the lumbosacral region.

Clinical History: The patient states that on the evening of August 22, 1924, he jumped two and a half stories to the ground, incurring an injury to his back.

Physical Examination: Examination reveals a patient who has suffered severe trauma in the lumbosacral region, evidenced by pain, tenderness, limited motion, ecchymosis, and muscle spasm.

Roentgenologic Examination: Roentgenograms reveal a definite forward displacement of the body of the fifth lumbar vertebra with a fracture of the left transverse process and a fracture through the alae of the sacrum. There is a defect in the neural arch of the fifth lumbar vertebra.

Fig. 2. Case No. 3

Tracing from roentgenogram. Lateral view. Note forward displacement of the fifth lumbar vertebra on the sacrum and break in contour of the neural canal.

Fig. 3. Case No. 4

Tracing from roentgenogram. Lateral view. Note the forward displacement of the body of the fifth lumbar vertebra upon the sacrum and the break in the outline of the neural canal.

Operation: September 23, 1924—A lumbosacral fusion was done.

Surgical Pathology: An incomplete neural arch and a fifth lumbar vertebra rotated upon its anteroposterior axis were seen. Mobility in the anteroposterior plane was very evident. The sacral and fifth lumbar defects were repaired by bridging the defect of the spinous processes of the third and fourth lumbar vertebrae.

This patient remained in bed for three months, then was supplied with a back brace and returned to the County Jail. At the present time he is doing hard labor in the penitentiary and has no discomfort whatsoever in his back.

CASE 5. Male. Age, 47 years.

Complaint: Pain and tenderness localized over the body of the sacrum.

Clinical History: The patient states that he was injured on March 13, 1924, when he was struck by an automobile and bumped along the pavement in a sitting position. He was seen shortly after the injury, but complained of very little discomfort at the lumbosacral level.

FIG. 4. CASE NO. 5
Tracing from roentgenogram. Lateral view. Forward displacement of the body of the fifth lumbar vertebra and offset in the neural canal are clearly seen.

Roentgenologic Examination: Roentgenograms revealed an anterior displacement of the body of the fifth lumbar vertebra and a transverse fracture through the body of the sacrum. The neural arch of the first sacral vertebra is incomplete.

Subsequent Findings: The patient remained in bed for thirteen weeks after a futile attempt to replace the fifth lumbar vertebra. He was then allowed to get up and about with a brace. Limitation of motion in the spine, tenderness, muscle spasm, and dull pain in the right leg and foot gradually grew worse, so that on August 18, 1925, a spinal fusion of the third, fourth and fifth lumbar and first sacral vertebrae was done.

Surgical Pathology: Abnormal anteroposterior mobility was the only important change present.

This patient had relief from pain shortly after his operation. He remained in bed for three months and on November 20 was allowed to be up and about with a back brace. At the present time he has no further discomfort in the back or legs and is wearing a back brace. Although it is rather early, the result promises to be very satisfactory.

CASE 6. Male. Age, 50 years.

Complaint: Severe pain in the back which radiates down the right leg to the dorsum and outer side of the right foot.

Clinical History: The patient states that he was injured on July 17, 1925, by slipping while carrying a heavy timber. He felt an acute lancinating pain in the lumbosacral region which radiated down the right leg. He was immediately disabled and remained in bed for about three weeks. At the end of this time he began to walk about with crutches but complained of pain along the outer aspect of the right calf and the dorsum of the right foot.

FIG. 5. CASE NO. 6
Tracing from roentgenogram. Lateral view demonstrating the forward displacement of the fifth lumbar vertebra.

Physical Examination: October 13, 1925—The patient walks with crutches. All lumbosacral movements are restricted. Definite tenderness is localized at the lumbosacral level. The right calf is 1.5 cm. less in circumference than the left. Straight leg lifting is limited and painful on both sides when stress is brought to bear upon the lumbar spine.

Roentgenologic Examination: Roentgenograms reveal a definite anterior displacement of the body of the fifth lumbar vertebra upon the sacrum.

Operation: October 26, 1925—A fusion of the fourth and fifth lumbar vertebrae and first sacral segment was done.

Surgical Pathology: The fifth lumbar vertebra was deep seated and very moveable in the anteroposterior direction. It could not be replaced.

This patient is still in bed but is entirely comfortable. It is too early to report the result of the operation in this case. The leg pain was relieved five days after the operation.

CASE 7. Female. Age, 9 years.

Complaint: This patient was brought in for examination because the mother felt that the child was unduly stiff and did not run and play as a normal child. The child also complained of pain in both legs, especially after exercise.

Clinical History: Upon further questioning the mother stated that the child fell from the drain board of a sink, striking the floor in a sitting position, when fourteen months of age. The mother feels that the child's back has not been normal since this accident.

Physical Examination: The lumbar segment of the spine seems to be shortened. The spinous process of the fifth lumbar vertebra is not palpable. There is a moderate amount of restriction of forward bending of the lumbar spine. Other motions are not restricted or painful. Straight leg lifting is limited to forty-five degrees on both sides and if forced beyond this point causes acute pain in the lumbosacral region.

Roentgenologic Examination: Roentgenologic examination disclosed a complete forward displacement of the body of the fifth lumbar vertebra upon the sacrum.

Comment: In view of the history as given by the mother it seems reasonable to believe that the spondylolisthesis which is so definite in this case is the result of the injury. There is a possibility, of course, that this condition is of congenital origin, although it seems rather doubtful. A spinal fusion was advised in this case but it was declined by the parents.

CASE 8. Female. Age, 64 years.

Complaint: This patient presented herself with a previous diagnosis of spondylolisthesis made by x-ray examination. She complained of severe pain of perineal and rectal distribution which had required large doses of morphine for relief over a period of six weeks. There was no history of trauma to the spine.

Physical Examination: The patient is a very heavy woman without an exaggerated lumbar curve. All motions of the spine are restricted. Tenderness is localized at the level of the fourth lumbar vertebra.

Roentgenologic Examination: Roentgenograms reveal a definite forward displacement of the body of the fourth lumbar vertebra upon the fifth.

Comment: At the time of the examination it was felt that the spondylolisthesis was perhaps of long duration and had no direct bearing upon the symptoms. However, the day following the examination the patient reported that she had received complete relief from her symptoms and had slept throughout the night without the use of morphine. Roentgenologic examination three days later revealed a normal alignment of the lumbar vertebrae.

This is a case of spondylolisthesis which was evidently reduced accidentally at the time of examination. It must have been responsible for the patient's discomfort, as immediate relief followed the replacement of the vertebrae.

CASE 9. Male. Age, 52 years.

Complaint: Pain in the back localized at the lumbosacral level.

Clinical History: The patient was examined because of a trivial injury alleged to have been incurred on December 14, 1925. He states that while getting out of an automobile he felt something catch in his back and has been unable to stand erect since.

Physical Examination: On admission to the hospital there was a list of the trunk toward the left. Muscle spasm was pronounced and present only on the left side. All movements of the spine were restricted. Straight leg lifting was not limited. The spinous processes of the sacrum were unusually prominent and the spinous process of the fifth lumbar vertebra seemed to be abnormally displaced forward. There were no changes in sensation or in the superficial or deep reflexes of the lower extremities.

Roentgenologic Examination: Roentgenograms reveal an extreme forward displacement of the body of the fifth lumbar vertebra upon the sacrum. Both posterior lumbar facets are distorted, apparently the result of an old injury. There is very marked increase in the density of the neural arch.

Comment: This case is simply reported as a definite case of spondylolisthesis. Treatment has not been undertaken as yet and although the man denies having had a severe injury it is believed that the question of compensation has clouded the issue. It is rather interesting to note that this man has been getting along even at light work with a pronounced lesion for several years.

CONCLUSIONS

1. Traumatic spondylolisthesis occurs more frequently in the male than in the female.

2. Severe trauma played an important causative rôle in all of the cases studied, with one exception.

3. The clinical history and physical signs do not differ materially from those of other irritative lesions of the lumbosacral articulation.

4. Lateral roentgenologic examination reveals the only positive evidence of the existence of spondylolisthesis.

5. An attempt may be made to reduce the deformity. This failing, the vertebra should be fixed by surgical measures.

6. Hibbs' spinal fusion offers a satisfactory means of operative fixation in spondylolisthesis.

My colleagues, Dr. H. W. Spiers, Dr. Steele F. Stewart and Dr. Harry J. Schott, have rendered valuable assistance and offered many helpful suggestions in the study of these cases.

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News Notes

ANNUAL MEETING OF THE AMERICAN ORTHOPAEDIC ASSOCIATION

The Annual Meeting of the American Orthopaedic Association will be held with the President, Dr. James T. Watkins, on June 13, 14 and 16 in the Yosemite Valley. This is the first time that the Association has met on the Pacific Coast and many unusual features have been planned by Dr. Watkins' committee in order that the members and guests may have an opportunity to see the natural beauties of the region and to enjoy the hospitality of the surgeons of the Western Coast.

The scientific program is being arranged by the Program Committee of which Dr. F. J. Gaenslen of Milwaukee, Wisconsin, is the Chairman. The final arrangement of papers will be given in the completed program. It is expected that, among others, the following papers will be presented:

Reconstruction Surgery of the Upper Extremities with Special Attention to Infantile Paralysis. Dr. Arthur Steindler

Utilization of Trapezius by Fascial Elongation for Deltoid Paralysis. Dr. Leo Mayer

Traction and Fusion in Scoliosis. Dr. C. L. Lowman

Reconstruction of Nerves and Tendons of the Hand. Dr. Sterling Bunnell

End Results of Transference of Crest of Ilium for Flexion Contracture of Hip. Dr. J. S. Speed

A Hitherto Undescribed Dystrophy Affecting Particularly the Joints of the Lower Extremities. Dr. C. F. Eikenbary

On High Dilutions of Tuberculin in Diagnosis of Bone Tuberculosis. Dr. Roland Adsatt

Fracture of Spine with Special Consideration of Ultimate Function. Dr. Clarence L. Starr

The Principles of Teaching Orthopaedic Surgery. Dr. Mark H. Rogers

Comparison of End Results of Treatment of Tuberculosis of Spine by Conservative and Operative Means. Dr. F. C. Kidner

End Results in Adult Knee Joint Tuberculosis. Dr. M. S. Henderson

Anatomical and Pathological Study of Knee Joint in Connection with Internal Derangement. Dr. J. O. Wallace

Conservative Treatment of Compound Fractures. Dr. Walter G. Stern

Circulatory Disturbances of the Extremities. Dr. George E. Brown

The Treatment of Acute Osteomyelitis by Drainage and Rest. Dr. H. Winnett Orr

Chronic Multiple Osteomyelitis with Recurrent Lesions of Bone and Deep Fascia. Dr. R. McE. Schauffler

Certain Considerations of Second Type Arthritis as Exemplified in the Shoulder Joint. Dr. Arthur L. Fisher

The Etiologic Factors in Certain Cases of So Called Sciatic Scoliosis. Dr. Robert B. Osgood

End Results Following Ramisection for Spastic Paralysis. Dr. S. F. Stewart

Haemangioma of the Os Calcis. Dr. S. Fosdick Jones

The plans for entertainment of the members and guests have been carefully arranged by the President and his committee with a view to interspersing work with relaxation; to inspect the work of the orthopaedic surgeons in Los Angeles and San Francisco, and to enable the visitors to appreciate the problems presented to the orthopaedic surgeons of the Coast, and also to afford the opportunity of visiting at least two of the great

natural wonders of the country. In these plans the President has had the loyal cooperation of the members of the San Francisco Orthopaedic Club and of the Los Angeles Orthopaedic Club.

The plans of the President and his committee arrange for the trip to California to be made on a special train over the Santa Fe, west of Chicago; one Pullman for the New England group to start from Boston; also one or more cars from New York, on which space may be reserved to be claimed at Philadelphia, Washington, or Baltimore; these eastern cars to be attached to the special train at Chicago, on which members and visitors starting from other points may secure reservations.

It is planned for the New England sleeper to leave Boston, via the Boston and Albany and New York Central lines, June 4 at 6.10 p.m., Buffalo June 5, at 8.30 a.m., Cleveland at 12.27 noon, reaching Chicago June 5, at 7.30 p.m.; the other sleepers to leave New York via the Pennsylvania Railroad June 4 at 3.05 p.m., West Philadelphia station 5.00 p.m., Baltimore 7.45 p.m., arriving in Chicago June 5 at 3.00 p.m.; the special train to leave Chicago June 5 at 8.15 p.m., Kansas City June 6 at 8.10 a.m., Albuquerque June 7 at 11.45 a.m., arriving at the Grand Canyon of the Colorado June 8 at 8.20 a.m. Wednesday, June 8, the day will be spent at the Grand Canyon, passengers may avail themselves of the hotels or remain in the Pullmans. Thursday, June 9, opportunity will be given to make the trip on mules down to the Colorado River. At 8 o'clock that evening the train will leave the Canyon, passing through Needles in the cool of the night, to arrive in Los Angeles at 2.15 p.m. on Friday, June 10.

The headquarters in Los Angeles will be at Gates Hotel. Friday evening, members and guests will be entertained at dinner by the Los Angeles Orthopaedic Club, at the Jonathan Club. Saturday, June 11, will be used in part as a clinical day. Arrangements have also been made for the guests to see the moving picture industry from the inside. At 6.05 p.m. on Saturday, the train will leave Los Angeles and will arrive at the Yosemite Valley in time for luncheon Sunday, June 12. Reservations there may be made for either The Awahnee, a new fire-proof hotel now being built, The Yosemite Lodge, conducted on the European plan, or Camp Curry, American Plan. The rates quoted are those of Camp Curry, the official headquarters in the Valley and include the use of redwood bungalows and bath.

The scientific meetings will be held on Monday, June 13, Tuesday, June 14 and Thursday, June 16. On Wednesday, June 15, opportunity will be given for an all-day trip to the Mariposa Grove of Big Trees.

On Friday, June 17, the party will leave for San Francisco. On Saturday, June 18, and Sunday, June 19, members will be the guests of the San Francisco Orthopaedic Club. Reservations in San Francisco may be made at the Fairmont or Mark Hopkins Hotels.

Those who wish to return immediately may arrange to reach the Eastern Coast on the evening of Thursday, June 23. For the benefit of those who wish to see the Northwest, the National Parks or Alaska, additional information has been secured. The following list, prepared by the Committee, is an approximate list of expenses:

Round trip Boston to San Francisco, ticket including side trips to Yosemite and Grand Canyon	$171.03
Pullman (lower berth, with 36 hours' occupancy at Grand Canyon)	78.52
Hotel, Los Angeles, parts of two days	5.00
Hotel, San Francisco, two days	10.00
Yosemite, five days	32.50
Meals, fourteen days (other than time spent in Yosemite)	70.00
Total	$367.05

The total cost from other eastern points will be correspondingly less. There will be an extra charge of $18.00 from most eastern points for tickets returning through the Northwest, also extra expense for sleepers, meals, stop-overs, etc.

A choice of six routes returning through the Northwest is offered, two of these routes across Canada. Crater Lake, Rainier, Glacier, Yellowstone or Jasper National Parks may be visited by easy side trips from certain of the Northern lines at varying additional costs. A stop-over at Portland, Oregon, allows for a half-day motor trip over the Columbia River Highway. Arrangements are also being made for the Puget Sound trip by boat from Seattle to Vancouver, to visit Lake Louise and Banff over the Canadian Pacific Railroad or Jasper National Park over the Canadian National Line. Both Canadian lines offer a two-day boat trip through Lake Superior and Lake Huron for an additional charge of $10.00, covering meals and berth.

For those wishing to see Alaska, trips to various points are available, all starting from Seattle or Vancouver, but accommodations are limited and early reservations must be made. A trip to Stewart, in Southern Alaska, can be made from Vancouver in four and one-half days at a cost of $60.00 on one of the Canadian National Lines' steamers, which leave Vancouver each Wednesday at 8.00 p.m. The same company offers a $90.00 trip of one week to Skagway, leaving Vancouver each Wednesday at 8.00 p.m. A trip to Seward and return occupies seventeen days. Steamers of the Alaska Steamship Company sail from Seattle every Saturday morning at nine o'clock. The cost is $156.00.

The President personally, in cooperation with the agents of the railroads, is making all arrangements for these trips and is planning for the comfort and pleasure of the members and guests. The completion of these plans depends upon an early response from those expecting to attend the meeting. All who are planning to attend should communicate as soon as possible directly with the President:

DR. JAMES T. WATKINS,
Hyde and Bush Streets,
SAN FRANCISCO, CALIFORNIA.

Literature concerning the trips, hotels and points of interest will then be sent, individual schedules worked out, and all arrangements made under Dr. Watkins' direction.

The Seattle Orthopaedic Society would like to meet and help entertain the orthopaedic surgeons who may stop in Seattle, going to and from the national convention in San Francisco. It is the desire of the Society to meet these men and have them take home pleasant memories of the Pacific Northwest. The Society would like to have the visitors get in touch with the Secretary, Doctor Joe Brugman, on their arrival in the city.

Word has been received of the death of Dr. George Perthes of Tübingen, Germany, on January 2, 1927.

Dr. Herman C. Schumm of Milwaukee has recently been appointed Associate Professor of Orthopaedic Surgery at the University of Wisconsin.

The *Journal* regrets to announce the death of Dr. Henry W. Frauenthal of New York on March 11. Dr. Frauenthal was founder and director of the Hospital for Joint Diseases, one of the largest, most fully equipped and best organized hospitals of its kind in the country, and was largely responsible for its development.

At the meeting of the **North Pacific Pediatric Society** held in Everett, Washington, on January 29, Dr. Charles F. Eikenbary, Superintendent of the Seattle Orthopaedic Hospital, led a discussion on "Hip Joint Disease in Children".

The following examination dates have been assigned by the **American Board of Otolaryngology:**

Washington, D. C: Episcopal Eye, Ear and Throat Hospital, Monday, May 16, 1927, at 9 o'clock.
Spokane, Washington: Saturday, June 4, 1927, at 9 o'clock.

It is proposed to hold a reunion dinner during the week of the **American Medical Association** Convention in Washington, May 16–20, 1927, provided enough men previously attached to Base Hospital No. 114, can be gathered together at one time. Any who will be in Washington for the Convention and would like to join the boys, should write to the former Commanding Officer, Dr. J. A. Talbot, 1621 Conn. Ave. N. W., Washington, D. C., as early as possible.

The Chicago Orthopaedic Club held a joint meeting with the Chicago Neurological Society at The Drake Hotel, on Thursday evening, January 20. The program included the following papers: "Sciatic Neuritis", presented by Dr. Hugh T. Patrick; "After-treatment of Infantile Paralysis", by Dr. Edward W. Ryerson; "Pott's Paraplegia", by Dr. John Ridlon; "Peripheral Nerve Injuries", by Dr. Lewis J. Pollock; "Arthritis of the Spine", by Dr. John L. Porter.

The program of the meeting held Friday evening, March 11, in the Crerar Library Building includes the following papers: "Dysostosis Cleidocranialis", by Dr. F. C. Test; "Presentation of Pathological Specimens", by Dr. F. A. Chandler; "Relation of Bone and Joint Pathology to the Roentgenogram", by Dr. B. H. Moore; and "Osteochondritis Deformans Juvenilis of the Shoulder", by Dr. Philip Lewin.

The next meeting will be held Friday evening, April 8, at eight o'clock, in the John B. Murphy Memorial Building, 50 East Erie Street. Dr. Robert B. Osgood of Boston will speak on "Arthritis". The following will participate in the discussion:

Dr. Frank Billings
Dr. Joseph L. Miller
Dr. D. B. Phemister
Dr. John L. Porter
Dr. Edwin W. Ryerson.

An invitation is extended to all who are interested.

The Boston Orthopaedic Club met in Sprague Hall of the Boston Medical Library, on Monday evening, February 14. The meeting was called to order by the President, Dr. Philip Wilson, who introduced the speaker of the evening, Dr. Arthur Steindler of Iowa City, Iowa. He spoke on the subject, "Reconstruction Surgery of the Upper Extremities", taking the various joints in their order: shoulder, elbow, wrist and fingers. He discussed at some length operative procedures devised by himself and others for the correction of deformities, particularly paralytic deformities of these joints. He emphasized the importance of studying the muscle balance in the shoulder before doing an arthrodesis, as the importance of position of the arthrodesed shoulder depends a great deal on the muscles remaining. In the elbow, he mentioned particularly the transplantation of the extensors upward along the outer border of the humerus as an accessory flexor. At the wrist he spoke about transplantations, particularly that of the flexor carpi ulnaris with the pronator radii teres along the back of the radius to act as supinator. He also mentioned arthrodesis of the wrist. The paper was well illustrated with lantern slides showing the details of some of the operations, as well as pre-operative and postoperative pictures of the cases. Discussion was opened by Dr. Brackett, who was followed by Drs. Osgood, Painter, Allison, Codman, Legg and others.

The next meeting will be held on Monday, April 4, at the Medical Library. It is

expected that the following papers will be presented: "The Development of the Treatment of the Cripple", by Dr. Osgood, "Fractures About the Elbow" by Dr. Allison, and "Orthopaedic Follow-up and End Result", by Dr. William Rogers.

It is hoped that the May meeting will be addressed by W. Rowley Bristow, of London.

The Southeastern Sectional Meeting of the American College of Surgeons, including Alabama, Florida, Georgia, Mississippi, Louisiana and Tennessee, met in Birmingham, on January 24 and 25. Some very interesting scientific papers were presented and clinics were held. At the Employees' Hospital of the Tennessee Coal, Iron and Railroad Company, Fairfield, Alabama, Dr. H. Earle Conwell presented an orthopaedic clinic, showing results and treatment of fractures of the spine, pelvis, extremities, chest, head and other orthopaedic cases. Dr. Wyatt Roberts presented an orthopaedic clinic at the Hillman Hospital, showing two cases of traumatic dislocation of the hip joint and other orthopaedic results. On the evening of January 24, Dr. Philip H. Kreuscher, of Chicago, read a paper with lantern slide demonstrations on knee joint injury, and on the following morning presented a paper on "Management of Fractures about the Joint". These papers were very instructive and were well received and greatly appreciated. The meeting was well attended. The next meeting will be in Tampa, Florida, January 1928.

The Minnesota Orthopaedic Club held its first quarterly meeting of the year on January 8, in St. Paul. Demonstrations of the open operation in the reduction of congenitally dislocated hips were given at the Gillette Hospital and at the Shriners' Hospital for Crippled Children, by Dr. H. P. H. Galloway, Professor of Orthopaedic Surgery at the University of Manitoba. A paper on "The Arthritic Knee" was read by Dr. Arthur Steindler, Professor of Orthopaedic Surgery at Iowa University. Ten cases of congenital hip in girl patients, now under treatment at the Gillette Hospital, were shown and discussed by Dr. H. Wallace Cole of St. Paul. Dr. C. C. Chatterton, Chief of Staff, also showed several cases of congenital hip in boys and a case (post-operative) of "Sprengel's shoulder".

A report on orthopaedic clinics, conducted throughout the state last summer under the auspices of the Minnesota Public Health Association, was made by Dr. Chatterton, and a committee of three members was appointed to arrange for carrying on the work during the coming summer. Dr. Charles Reed, of Minneapolis, was elected President of the Club for the coming year and Dr. H. J. Fortin of Rochester, was made Secretary.

It was decided that the next meeting of the Club should be held in Minneapolis in the spring,—the exact date to be announced later by the President.

On January 21, ground was broken for the **Elks' Convalescent Home for Crippled Children,** on Lake Ballinger, a few miles out of the city of Seattle. This Convalescent Home is to be started with fifty beds; eventually the capacity will be developed to one hundred beds or more, as the need is demonstrated. The Home will be run as a sort of adjunct to the Children's Orthopaedic Hospital of Seattle and will, undoubtedly, enable the present Children's Hospital to almost double the number of cases which it can handle. Buildings are to be strictly fire-proof and modern in every particular. Facilities will be provided for all sorts of educational therapy. The grounds are very extensive, affording ideal conditions for getting the children into the open air. Among other things, it is planned to have flower gardens and vegetable gardens conducted by the children. The surgical end of the work will be cared for by Dr. C. F. Eikenbary.

The Oklahoma Society for Crippled Children has won a legislative victory in its state. An appropriation bill granting the State University Medical School

$307,000 for the addition of a children's hospital has just been passed. A companion measure was also passed which revises the former law, providing state aid for crippled children. The old law, enacted six years ago, provided that all indigent crippled children could be ordered to the State University Hospital by the court and the expenses charged to the county from which the child came. The new law provides that hospitals other than the University Hospital can care for these cases, provided that they be approved by the faculty of the Medical School. Orthopaedic surgeons doing such work must be approved by the University Hospital. The bill carries a one-tenth mill *ad valorem* tax levy for each county. No surgeon is to receive remuneration, but the hospital fees are established as $15.00 per week, including all expenses of hospital care, even to braces. This latter provision forces the burden of deficiency on the state, but will require the aid of philanthropy in private hospitals. The Oklahoma Society feels proud that every request made by it is provided for by these two laws.

A New Orthopaedic Hospital in British Columbia. Through the efforts of the Women's Institute Hospital Association of British Columbia, an organization similar to the Grange of the United States, a fund has been collected and a new hospital for crippled children inaugurated. Vancouver, B. C., is the home of the institution; Dr. F. C. McTavish of that city is the attending orthopaedic surgeon.

The Association now operates a solarium of twenty-five beds, especially to provide heliotherapy for tubercular joints. However, the activities during the past three years have covered a wide range of deformities. Plans have been perfected for the purchase of a four-acre tract and large dwelling upon Shaughnessy Heights, the beautiful plateau rising above Vancouver. The building will be adequate for the present, and additional buildings are contemplated. It is anticipated by Mrs. Duker, the President, that the Association will proceed at once to install a full, complete and modern equipment and that the Vancouver Hospital will be rapidly brought to a par with other western orthopaedic institutions.

At the annual meeting of the Women's Institute Hospital Association held on February 21, in Vancouver, the project was given its final endorsement. The annual address was given by Dr. Edward A. Rich of Tacoma, Washington, upon the subject, "The Progress of Orthopaedic Surgery".

THE ANNUAL MEETING OF THE INTERNATIONAL SOCIETY FOR CRIPPLED CHILDREN

HELD AT CINCINNATI, OHIO, FEBRUARY 16 AND 17, 1927

Reported by Dr. Earl D. McBride, Oklahoma City, Oklahoma

At no time in the history of medicine has the profession attracted the whole-hearted and enthusiastic support and cooperation of the laity as has the specialty of orthopaedic surgery in these days. At the convention held in Cincinnati, there were present representatives from twenty-one different states. Orthopaedic surgeons from twelve states mingled and conferred with lawyers, business men, nurses, social workers and school teachers. The one and only purpose of the meeting was to study further how to care for, relieve and educate the crippled child,—a compliment indeed to those pioneer orthopaedic surgeons who long ago laid the foundation for triumphs of modern reconstructive surgery.

The International Society for Crippled Children was organized at Toledo, Ohio, on October 14, 1921. Headquarters are now at Elyria, Ohio. It was the direct result of a spectacular orthopaedic case which the Toledo Rotary Club was instrumental in bringing to operation and rehabilitation.

Dr. Burt G. Chollett of Toledo, deserves credit for the early steps in organizing this movement and has been a guiding hand in its rapid extension throughout the United

States and Canada. The President of the Society, Mr. Edgar F. Allen, of Elyria, Ohio, better known as "Daddy Allen", has been the motive power of the movement. A business man of some means, he financed a hospital in his home city several years ago, in memory of his son, who was severely injured and died as a result. When the Rotary Club began an organized movement in behalf of crippled children, this man grasped the opportunity for service to humanity and since then has devoted his entire time to the movement without remuneration. In the past year, he has traveled 43,000 miles and visited twenty-one states.

There are now thirty-nine societies affiliated with the international organization. Eleven state societies were established in the past year. The object is to furnish a medium through which all agencies interested in caring for, relieving and educating the physically handicapped, can work together in an effective and coordinated manner.

Such an organization has influence in securing special legislation and better educational advantages. Surgery and clinics are opening the eyes of the laity and creating a deeper respect for the accomplishments of the medical profession as a whole. They are also disclosing opportunities which the medical profession itself did not realize existed.

The professional phase of the conference was under the direction of Dr. Albert Freiberg of Cincinnati. Dr. Frank Dickson of Kansas City, Dr. Frederick J. Gaenslen of Milwaukee, Dr. Burt G. Chollett of Toledo and Dr. Willis C. Campbell of Memphis, led in discussions.

The three main topics were:

1. How shall supervision of after-care be provided for, subsequent to operations or hospital treatment?

2. Could an annual clinic or conference of medical character be held to discuss certain professional problems in order to reach a common understanding?

3. Can standards of results be arrived at by referring certain subjects to committees, such as: What constitutes a cure in congenital clubfoot (meaning discharge from all treatment)?

The following motion was carried: Formal invitation shall be extended to the American Orthopaedic Association and to the Orthopaedic Section of the American Medical Association to send delegates to the annual meetings of the International Society for Crippled Children.

The *Journal* is glad to publish the following letter received from Dr. Bloodgood. Readers of the *Journal* will certainly be interested in this work which Dr. Bloodgood is doing and will desire to cooperate with him in every way possible.

Editor.

Baltimore, February 3, 1927.

TISSUE DIAGNOSIS IN THE OPERATING ROOM

And Immediate Cover-slip Examinations of all Fluids and Pus

Dear Sir:

I will consider it a courtesy if you will publish this letter in your journal, as I am anxious to come in correspondence with pathologists and surgeons interested in the immediate examination, by frozen section, of tissue in the operating room and the immediate cover-slip studies of smears from all fluids and pus.

Microscopic examination of stained frozen sections has been possible for more than a quarter of a century. The staining of unfixed frozen sections with polychrome ethmylene blue and other stains is a well established procedure. In many operating rooms in university and other large and small surgical clinics, provisions for these immediate diagnostic studies have not only been available, but have been in practical use for years. On the other hand, unfortunately, this diagnostic part of the operating room is conspicuous by its absence in many clinics.

Before 1915 it was rarely necessary for a surgeon well trained in gross pathology

to need a frozen section to help him in diagnosis at the operating table. Since 1915, and especially since 1922, the public has become so enlightened that malignant disease, formerly easily recognized either clinically or in the gross, now appears in our operating rooms devoid of its easily recognized clinical and gross appearance and can only be properly discovered by an immediate frozen section. The majority of operating rooms are not equipped or prepared for this new diagnostic test.

The first essential for this diagnosis is the technician,—one to cut and stain the frozen section, or to make and stain the smear. The second is a pathologist trained to interpret it. It is possible for the surgeon to be all three in himself, and some young surgeons are so equipped. In others it is a dual combination—surgeon and pathologist in one, and the technician. More frequently it is three—operator, technician and pathologist. It makes little difference whether it is one, two or three individuals, providing each has the equipment and training for this most difficult diagnostic test.

In the address as Chairman of the Surgical Section of the Southern Medical Association, I discussed biopsy, and this paper has been published in the Southern Medical Journal for January 1927 (Vol. XX, page 18). A reprint of this paper will be sent to anyone on request. The chief object of this letter is to come in contact with surgeons and pathologists who are sufficiently interested in this problem to discuss it either by correspondence, or by attending a meeting in the surgical pathological laboratory of the Johns Hopkins Hospital, either the Monday before, or the Friday after the meeting of the American Medical Association in Washington.

Schools for technicians may have to be established in different sections of the country, and the surgical pathological laboratories of the medical schools and the larger surgical clinics should offer courses in this tissue diagnosis, so that surgeons may learn to become their own pathologists, or pathologists learn the particular needs of the surgeon in tissue diagnosis in the operating room.

It is quite true that when the majority of the public are fully enlightened, the surgeon will see lesions of the skin and oral cavity and the majority of subcutaneous tumors when they are so small that their complete excision is not only indicated, but possible without any mutilation. The chief danger here will be a surgical mistake—the incomplete removal of an apparently innocent tumor. There is no necessity here for biopsy. If a proper local excision is done, no matter what the microscope reveals, that local operation should be sufficient. But when lesions of the skin, oral cavity and soft parts are extensive and their complete radical removal mutilating, then there must be biopsy to establish the exact pathology.

In tumors of the breast and disease of bone, for years, the diagnosis could be made clinically, or from the gross appearances at exploration. But now an increasing number of cases of the breast tumor must be explored, and the gross pathology of this earlier stage is not sufficiently differentiated to allow a positive diagnosis. Immediate frozen sections are essential to indicate when the complete operation should be done. The same is true of the earlier stages of lesions of bone. The x-rays no longer make a positive differentiation between many of the benign and malignant diseases,—for example sclerosing osteomyelitis and sclerosing osteosarcoma.

We must not only specialize in tissue diagnosis, but we must organize this department so it will function properly in as many operating rooms as possible in this country.

Then there is a final and most difficult question to consider. I doubt if it can be settled. What shall be done in those operating rooms in which there is no technician to make the sections and no one trained to interpret the microscopic picture? How can a piece be excised or a tumor removed, for example, from the breast, and this tissue sent to some laboratory for diagnosis without incurring the risk of the delay to the patient. I have discussed this point in my paper on biopsy.

Joseph Colt Bloodgood,
Surgical Pathological Laboratory,
Johns Hopkins Hospital.

CLINICAL CONFERENCES AT THE HOSPITAL FOR RUPTURED AND CRIPPLED, NEW YORK CITY

CONFERENCE OF DECEMBER, 1926

DR. P. C. COLONNA—Fracture, Dislocation of Sacro-Iliac Joint.

Dr. Colonna presented a case with marked separation at the sacro-iliac joint, in a girl four years of age. In May 1926, the child was struck by a touring car, knocked unconscious and dragged about fifteen yards. She was immediately taken to the hospital where she rapidly recovered consciousness and complained of pain in the thigh and back. X-ray examination of the pelvis revealed a wide separation with upward displacement of the ilium at the left sacro-iliac joint. Further examination showed no muscle or nerve involvement other than contusion to the thigh muscles. The back was strapped with adhesive plaster and the child was kept in bed. There was little or no discomfort from the fracture dislocation of the sacro-iliac joint, and the child was walking about the ward within four weeks after injury. Strapping of the back was continued and the child kept under observation in the hospital until the middle of July. She has been returning for observation since her discharge. X-ray taken to-day shows the wide separation seen in the original x-ray. The child walks well, complains of no backache, has no local tenderness, and the movements of the spine are normal.

DR. R. WHITMAN—Bifurcation Operation for Old Tuberculosis of the Hip Joint.

Dr. Whitman said one should have at command a variety of expedients to meet special indications. One of those was the Lorenz bifurcation operation.

The first patient, a woman twenty-seven years of age, has had, apparently in early childhood, an infectious arthritis of the hip. This had resulted in a pathological dislocation, the distorted head resting in a secondary acetabulum on the side of the pelvis. Except for the limp, there had been but slight disability until nine months ago, but since then there had been increasing pain and local sensitiveness about the joint which had obliged her to give up work.

In this case the symptoms and the x-ray findings indicated what might be called a secondary traumatic arthritis in the ill formed joint, analogous to arthritis deformans, for which the obvious remedy was relief of weight-bearing and friction. Consequently the operation had been performed a month before. A long oblique section of the femur was made, the apex being opposite the acetabulum. The shaft fragment having been completely detached, its bayonet-shaped upper extremity was thrust inward toward the acetabulum at an angle of about twenty-five degrees of abduction. The x-ray picture taken through the plaster shows that this has been accomplished and that the upper fragment is adducted, so that the deformed head of the femur is completely separated from the rudimentary acetabulum. It is assumed that after the fragments are united, weight will be borne chiefly on the shaft of the femur and that motion will be supplied by the muscles attached about the trochanter.

The second patient, a girl nineteen years of age, had been under observation for hip disease for fifteen years. During a part of this time she considered herself well, having a free range of motion at the joint, no pain and but a slight limp. Within the past year, she had become almost completely disabled from a return of pain and sensitiveness to motion. The x-ray picture explains the former free mobility since the acetabulum is greatly enlarged while the head of the femur has been destroyed leaving only the neck. In this case the success of any ankylosing operation, the usual remedy, would be very doubtful and consequently the bifurcation operation was performed several weeks ago, the effect being the same as demonstrated in the first case. It is assumed that the relief of the sensitive joint from direct weight-bearing will relieve the symptoms.

DR. L. C. WAGNER—An Unusual Lesion of the Hip Diagnosed as Tuberculosis.

Dr. Wagner presented the case of a patient, thirty-one years old, who has had a very strong family history of tuberculosis. In October, 1925, he began to feel run down and to lose weight, although he kept at work. He ran a slight elevation of temperature. In May, 1925, he began to complain of pain in his left hip and walked with a limp. In August, 1926, it was necessary for him to stop working and go to a hospital for treatment.

At this time a thorough examination revealed the patient under par. He had lost about twenty pounds of weight, but was normal except for the left leg. He walked with a limp and protected the left hip. There was atrophy around the thigh and calf. Measurement in length of both legs was the same. There was spasm of the muscles about the hip and all the motions were restricted. There was a slight adduction deformity. There was no sign of abscess but tenderness about the joint posteriorly was made out. X-ray examination showed an atrophy of the acetabulum and upper end of the femur, which was thought to be due to disuse. The joint space was obliterated, although the contour of the head of the femur seemed to be normal. A diagnosis of tuberculosis of the hip, very early, was made. It was decided, in order to shorten the disease, to have a fusion operation of the Hibb's variety. A flap above the acetabulum was raised and the trochanter removed, freshened and turned upon itself, and placed under the flap. Patient made a satisfactory recovery, but was never free from pain.

At the end of six weeks, the plaster was removed and x-ray made, which showed no increase in the disease. Plaster was left off and patient complained incessantly of pain, which required morphine. He lost weight and his temperature from the time gradually became higher. He had a slight cough and we felt that the tuberculosis had extended to the chest. At the end of three months from the operation, although the x-rays at the end of two months were taken and found satisfactory, a check-up was made and x-rays of chest and hip retaken. X-ray of the hip showed an extreme destruction by sarcomatous degeneration of the acetabulum, the ilium and central dislocation of the head of the femur. X-ray of the chest showed metastatic areas.

In conclusion this was a mistaken diagnosis. The symptoms were very similar to tuberculosis. It appears that although before operation it was a very slow growth, after operation the condition has progressed very rapidly.

Dr. R. Kahle—Fracture, Dislocation of First Metacarpophalangeal Joint. Open Operation.

Dr. Kahle presented the case of a patient, G. L., age twenty-six, with an irrelevant past history and family history. The patient stated that in April, 1926, he injured his right thumb due to a "back fire kick" while cranking a truck engine.

He received treatment from his family doctor consisting of wet dressings. At the Insurance Company Clinic an x-ray was taken and no attempt at setting was made. He was dissatisfied with the physiotherapy treatment given, as he saw no improvement from it.

Physical examination when admitted to First Orthopaedic Division of this Hospital on October 29, 1926, showed the patient to be in good general condition. He presents a marked resistance of all motions of the metacarpal bone of the thumb. It is held in an attitude of adduction. All active and passive movements are markedly restricted. Abduction is much restricted. There is slight pain on use. There is muscular atrophy about the thumb.

X-ray examination shows almost complete displacement of the metacarpal bone on the carpal bone and a fragment of bone in the joint space. On November 1, 1926, operation was performed and through a straight incision, longitudinally dividing the tissues of the anatomical snuff box, the base of the first metacarpal bone was exposed and freed. A small fragment of tissue which was thought to be the bony fragment seen in the x-ray was removed. (This on bisection was a cartilaginous fragment.) The proximal end of the first metacarpal bone was replaced into the joint space and the capsular tissues and subcutaneous tissues were tightly approximated with interrupted sutures. Skin closed with a running catgut suture. A plaster-of-Paris bandage was applied from the tip of the thumb to the elbow with the thumb in complete abduction. Postoperative x-ray shows complete replacement of the dislocation. In three weeks the bandage was removed. The wound was clean and healed. For one week active motion with a sheet wadding dressing was instituted. Since then he has been given physiotherapy treatment in our hospital physiotherapy department. He now shows

complete range of all motions of the thumb except abduction which is only ninety per cent. The x-ray shows complete replacement of the dislocation.

There are two points of interest in the case: First,—the fallacy of physiotherapy treatment of a thumb definitely dislocated without an attempt made to replace it. Second,—the very good functional result obtained by open reduction replacement with ninety per cent. functional loss of abduction in seven weeks after operation.

DR. A. WHITMAN—Septic Arthritis of the Hip Cured by Operation.

Dr. Armitage Whitman presented a case of acute, suppurative arthritis of the hip. The patient was a Russian sixteen years of age, a pupil in a ballet school. She was first seen in consultation with Dr. Poltchaninoff, April 13, 1926. She gave a history of sudden, spontaneous onset of pain in the hip running down the leg, accompanied by fever and general constitutional disturbance, unaffected by rest and the ordinary remedies. Twenty-four hours before, her doctor had aspirated the hip and obtained a few drops of cloudy serum which was reported to contain a pure culture of staphylococcus aureus.

The patient was pale, in poor condition, appeared sick. The temperature was 102 degrees. Her white blood count was 15,200 with seventy-eight per cent. polymorphonuclear leucocytes. All motions of the hip were practically completely restricted by pain and spasm. There was tenderness to pressure over the joint. The hip joint was exposed by a posterior incision. The capsule of the joint was normal in appearance so that instead of opening it, a needle was introduced and a few drops of cloudy serum withdrawn. This was later reported from the hospital laboratory to contain staphylococcus aureus in pure culture.

A silk worm gut twist was left in place leading down to the joint, and the wound loosely closed. It was thought that it would possibly be necessary to open the joint later.

In three days the patient's pain was practically relieved. Her temperature fell gradually but steadily, and in two weeks was normal and remained so. The wound discharged small quantities of cloudy serum, but no frank pus; at the end of a month it cleared altogether. Motion in the joint rapidly improved and at the time of her discharge to Neponsit Hospital, to which she was admitted through the kindness of Dr. Whitbeck, she had full extension, flexion to ninety degrees. The patient now walks without a limp, all motions of the hips are normal. Except for the scar it is impossible to determine the affected limb. She has resumed her occupation as a ballet pupil.

The x-ray showed a very slight enlargement of the head and neck of the femur, and the affected limb is a quarter of an inch longer than its fellow.

Although the success of the case could hardly be attributed entirely to the operation as the joint was not opened, the incision and puncture must have had some effect in allowing the escape of the cloudy fluid which, following the operation, did escape. Dr. Whitman thought it an interesting example of what might take place following early diagnosis and prompt treatment.

CONFERENCE OF JANUARY 1927

DR. J. E. SUTTON, JR.—Chondroma of Foot.

Dr. J. E. Sutton, Jr. presented a patient, Miss A. C., aged forty-two. She was first seen September 17, 1926, complaining of a swelling on the lateral side of the right foot. This was painful on walking and when pressure was applied to it. About September 1921, she had what was called "rheumatism" of same foot and ankle. One year later, she noticed a small, firm mass on the lateral side of her foot. An operation was performed for removal of this mass. A small swelling remained which gradually increased in size. She was well developed and well nourished, but had bilateral weak feet. On the lateral surface of the right foot in the region of the internal portion of the calcaneum and over the right cuboid, there is an irregular lobulated hard mass about one by two inches. Skin over this mass is adherent along line of scar from previous operation.

X-ray examination showed a soft tissue swelling below and anterior to right external

malleolus, containing numerous irregular areas of calcifications. There was no definite bone destruction.

Operation was performed October 1, 1926, under general anaesthesia. A two-inch incision was made in the lateral surface of the right foot, extending from a point just below the external malleolus towards the base of the fifth metatarsal. An irregular, lobulated, firm mass was easily separated from the surrounding tissues. This mass was attached firmly to the lateral surface of neck of calcaneum and to the cuboid bone. It extended downward to base of fifth metatarsal and completely surrounded the peroneal tendon. These tendons were perfectly normal and easily separated from the mass. With a periosteal elevator, the mass was separated from the os calcis and the cuboid. During the operation the calcaneocuboid joint was open. Visible cartilage of the joint was curetted with small curette. The subcutaneous tissues and skin were closed in the usual manner.

Pathological report: Chondroma without complications.

Examination four months later shows the condition apparently cured.

Dr. A. Krida—Postural Treatment of Traumatic Deltoid Paralysis.

Dr. Krida presented a case illustrating the striking result occasionally obtained by postural splintage. The patient was a man thirty-three years of age. He had dislocated his left shoulder eight weeks previously. It had been reduced after forty-eight hours. He was seen at the end of fifteen days, and presented the typical disability associated with paralysis of the deltoid muscle. No action could be discovered in that muscle.

A plaster spica with the left upper extremity in ninety degrees abduction, was applied. After three days, the extremity portion of the spica was bivalved. Slight activity could already be demonstrated in the deltoid. At the end of three weeks, there was considerable power in the muscle; the spica was removed and physiotherapy begun. At the end of three weeks more, recovery of the muscle seemed to be complete.

Dr. S. Kleinberg—A Case of Infectious Arthritis of the Knee.

Dr. Kleinberg presented a woman twenty-six years of age. He first saw her on September 22, 1926. Her chief complaint was excruciating pain in the right knee joint of one week's duration. At that time patient was toxic, had slight fever and the right knee was swollen. The lesion was assumed to be one of acute catarrhal synovitis with effusion, and aspiration was advised.

Dr. Kleinberg made a stab wound in the knee on September 22, and eight ounces of cloudy fluid showing fibropurulent masses were evacuated. Culture was negative. There was no relief of symptoms, and five days later the joint was opened widely through two lateral incisions. At this time there was only a moderate quantity of cloudy fluid but numerous masses of fibropurulent tissue. The synovial membrane was grayish, friable and hemorrhagic. The joint was thoroughly washed with saline solution, and through and through drainage was established.

At this time x-ray pictures showed no involvement of the articular cartilage or of the bones of the knee joint. It was hoped that the Willen's treatment could be carried out. This however was unsuccessful; fever continued, general condition of the patient was not satisfactory. All laboratory tests were negative except for a moderate leucocytosis.

Pain on the inner side of the knee and tenderness over the internal condyle developed and an x-ray picture showed a small erosion of the condyle. An exploratory operation was therefore decided upon with the idea of removing whatever diseased tissue was found.

Accordingly, an exploratory operation was performed on November 22. The quadriceps bursa was found to be completely obliterated, much diseased soft tissue was found, surrounding the patella on either side of the patellar ligament.

Dr. Kleinberg stated that his chief interest in this case lay in the fact that, in retrospect, he believed that within the first week of this patient's illness, when the disease was limited to the soft tissue, had he been brave enough to perform a synovectomy, he might have prevented inflammatory invasion of the bones and might have obtained healing with partial or complete mobility of the knee.

Current Literature

HELIOTHERAPY. By A. Rollier. Translated by G. de Swietochowski, London, Humphrey Milford, Oxford University Press, 1927.

Dr. Rollier has published a new edition of his work entitled "Heliotherapy", which first appeared in 1923. The work is more than a revised edition, for it not only discusses the changes and improvements which have occurred during these years in the application of heliotherapy and presents a new series of cases and results, but it also takes up the consideration of the subject from the etiological and chemical and physiological point of view, and gives results of the investigation and experimentation with the substitute lights. The first chapters are of particular value, giving, as they do, first an historical sketch of the employment of heliotherapy, in which he states there is evidence to believe in its employment at the time of Herodotus. Although he answers the criticisms which have been made of his paternalism of heliotherapy, one can hardly be otherwise than convinced of the very prominent part which he has played in bringing this form of treatment to the attention and the acceptance at the present time. The chapters on the experimental contributions give in a concise manner much valuable information to those who wish to understand this part of the problem; and the chapters on climatology with the directions for dosage, etc., will be found of aid in the application of this therapy, which in spite of a contrary opinion requires skill and experience for its successful employment. Naturally the book largely deals in its clinical portion with heliotherapy for tubercular bone affections. It is profusely illustrated, and cases are given showing the conditions before and after treatment. The results obtained in treatment of lupus are striking, and go far to still further emphasize what now is of gradual emphasis, viz., the beneficial treatment of the sun's rays on this affection. A portion of the book is devoted to the prophylactic use of this form of therapy.

Dr. Rollier has had in the immediate vicinity of his hospital area a school in the open, and the methods used and the results obtained are shown. A small portion of the book is devoted to the employment of the heliotherapy on the non-tubercular affections which are worth studying, particularly of those conditions which have to deal with the more superficial areas, non-tubercular in character. The book also contains a valuable and complete bibliography, and it is a contribution which is of value not only to the specialist interested in the bone affections but also to the general practitioner.

L'ARTHROPLASTIE DU GENOU. By Charles-Henri Chevallier. Paris, Masson et Cie, Editeurs, 1926.

The author has treated the subject of arthroplasties of the knee in a comprehensive manner, and has paid especial attention to the various conditions which have bearing both on the development of the affections which demand this procedure, as well as on the operative procedure itself. He gives the three characteristic steps of the technique of the operation: (1) the freeing of the ankylosis itself; (2) remodelling of the opposing surfaces of the joint to be reconstructed as near as possible to the normal shape; (3) the interposition between the opposing surfaces of bone of some material to prevent their reunion. The book is divided into four parts:—in the first is considered the embryology as well as the normal development of the growth of the joint; in the second, the study of the gradual evolution which has directed the operative procedures toward arthroplasties, and comparison of the various methods; in the third, the consideration of technique; the fourth deals with the results which are obtained. The first two portions are

of particular interest since they discuss briefly but quite thoroughly the questions to which as a rule insufficient attention is given. In the portion devoted to the technique of operation, the different methods of operation,—both of approach and remodelling of bones, as well as the choice of the material to be used in interposition, also the question of mobilization after operation,—are thoroughly discussed. In the fourth portion is given results, not only of the author's cases, but also of the cases which it has been possible for the author to collect. In this way he gives the results of 348 cases of various operations and has added to these the statistics of Professor Putti of sixty-three cases collected and published by him. The book also contains an excellent and comprehensive bibliography of the subject.

Dr. François Minár in *Liječnički Vjesnik*, Zagreb, Yugoslavia, Nov. 1925, published an interesting observation on two cases of congenital dislocation of the hip occurring in twins, both females. There was extreme difficulty in delivery. They began walking at eight months. At age of a year and a half, there was noticed a distinct limp and the parents sought advice when the children were two and one-half years old, on account of limp and peculiar wabbling gait. On examination there was found to be a limp, the Trendelenburg symptoms on the left side, trochanter prominent and above Nélaton's line and the x-ray showed a posterior subluxation. Dr. Minár considered that these two cases have particular points of interest which may be instructive as to the etiology. A reposition was made by the method of Paci-Lorenz with a complete cure after six months. Dr. Minár states that there is but little known concerning the co-existence of the congenital dislocation on the same side in twins, but it has been observed by other surgeons; in any case, the condition seen is apparently unusual and the literature in regard to it adds but little to what is known of the subject. He states that he has been interested in the etiology of congenital dislocation of the hip during the last thirty or forty years of practice, and has given special study to the problem of the theory of etiology. He uses this case as a basis for discussion of this part of the question. He states that there are now advanced four theories: (a) traumatic, or the mechanical influence, (b) fault of development, (c) intra-uterine disturbance of nerve origin, medullary or peripheral, (d) osteogenic defects.

The author then discusses at length and very intelligently the different theories, giving the facts which support them, and also gives the reasons which different authors have presented in support of the different theories.

After reviewing the principle theories which have been supported, and also in view of the unilateral symmetry in the deformity in the case of the two twins, he considers that one is forced to abandon the theory of the mechanical influence, and to favor more strongly the theory of some fault of development. It may be necessary also to attach to this malformation some fault of development of the articulations, which is predisposed either by some unknown or by some inherited influence.

The *Journal* wishes to acknowledge the receipt of the following books sent to the Editorial Department:

International Clinics. Volumes III and IV, Thirty-sixth Series. Philadelphia and London, J. B. Lippincott Company, 1926.

Transfusion of Blood. By Henry M. Feinblatt, M.D. New York, The Macmillan Company, 1926.

Report on Third International Congress of Military Medicine and Pharmacy. Paris, April, 1925. By William Seaman Bainbridge, M.C., Washington, The Military Surgeon, 1926.

Cannula Implants and Review of Implantation Technics in Esthetic Surgery. By Charles Conrad Miller, M.D., Chicago, The Oak Press, 1926.

This Business of Operations. By James Radley, Cincinnati, The Digest Publishing Company, 1927.

ISCHAEMIC CONTRACTURE—EXPERIMENTAL STUDY. Paul N. Jepson. *Ann. Surg.*, LXXXIV, 785, Dec. 1926.

A good definition and concise review of the literature is given at the beginning of this article. Experiments were carried out upon dogs. Ether was used. In the first series attempts were made to produce the deformity by means of splints, casts, and bandages, but these attempts were unsuccessful. In the second series an Esmarch rubber bandage was used, and left on for varying periods of time. This produced only a temporary deformity. In the next series, dogs were operated upon in pairs, one having the femoral vein ligated, the other having an incision made six cm. below Poupart's ligament, encircling more than one third of the thigh and running down through fascia to the muscle. In both animals the extremity operated on was cold and bluish within a few minutes. A deformity resembling main-en-griffe deformity developed in both and persisted for from six to nine days. In the next series the two operations were combined. Almost the same deformity developed and lasted a few hours longer. After the wounds had healed, an Esmarch bandage was applied at the site of operation and left on for six to twenty-four hours. These animals developed typical deformity which in some persisted from two to eighteen months. After having produced the deformity, the next procedure was to determine a method of preventing it. An Esmarch bandage was left on for eight hours—there was oedema and signs of poor circulation and beginning contracture of the toes. Six hours later the wound was opened, blood and serum evacuated and two drainage tubes placed deep in the intermuscular space. The next day the swelling had gone down, and four days later the dog was walking normally. The experiment was repeated often enough to bring out the fact that intrinsic pressure is a factor in this condition. The author concludes that the contracture is due to several factors: the impairment of venous flow, extravasation of blood and serum, swelling of the tissues with consequent pressure on the blood vessels and nerves in the involved area. If this be true, early incision with drainage would be of value.—*F. G. Hodgson, M.D., Atlanta, Ga.*

MECHANICAL DERANGEMENTS OF THE JOINTS. Melvin S. Henderson. *Ann. Surg.*, LXXXIV, 796, Dec. 1926.

The author deals clearly and concisely with a number of disabilities of particular interest to industrial surgeons. He includes slipping peroneal tendon; mechanical derangement of the knee, due to displaced semilunar cartilages and loose bodies; habitual dislocation of the patella; snapping hip; loose bodies in hip; trigger finger; habitual displacement of the ulna; dislocation of the head of the radius; loose bodies in the elbow; habitual dislocation of the shoulder; acromioclavicular and sternoclavicular dislocations.—*F. G. Hodgson, M.D., Atlanta, Ga.*

OSTEOPLASTIC SUPPORT OF THE SPINE IN POTT'S DISEASE. R. R. Wreden, Leningrad, Russia. *Ann. Surg.*, LXXXV, 35, Jan. 1927.

The difficulty or impossibility of securing and maintaining proper support of the spine by means of braces or orthopaedic corsets led the author to devise a means of supporting the spine on the pelvis as well as fixing the vertebrae. In disease of the lower dorsal and lumbar region he transfers the weight of the trunk from the diseased vertebrae to the pelvis. In cases where the fourth and fifth lumbar vertebrae are involved he places as a transverse support or "osseous rafter" a strong bone graft resting on the iliac crests and upon which the spine of the third lumbar vertebra rests. The operation is described in detail. Patient is kept flat in bed for six weeks and begins to walk after seven weeks with no additional support. For disease higher up he uses an oblique support consisting of two long bone grafts acting as a trestle. The lower ends of the grafts rest, one on each side of the iliac crest and the upper ends cross under the spine of the lowest sound vertebra. The after-treatment is the same as for the transverse support. Ten cases have been operated on with satisfactory result.—*F. G. Hodgson, M.D., Atlanta, Ga.*

THE REPAIR PROCESSES IN WOUNDS OF TENDONS, AND IN TENDON GRAFTS. John H. Garlock. *Ann. Surg.*, LXXXV, 92, Jan. 1927.

This reports experimental work upon dogs. Fine silk sutures were used. In simple tenorrhaphy the process of repair is similar to that in other soft parts. During the first three days the scar will not stand stress and strain. After the fifth day the scar stretches somewhat but not to a marked degree. After this day the scar will stand active motion. After the fifth day the scar gradually increases in strength and density. After the twenty-eighth day it was difficult to find the point of suture. Tendon grafts were shown to live as such and the process of repair was similar to the simple suture. He concludes that after a tenorrhaphy, active motion within the limits of pain may be started after the fifth postoperative day, passive motion not before the fifteenth or sixteenth day. After a tendon graft, active motions may be started on tenth day but apparatus should not be removed until the twenty-fifth day.—*F. G. Hodgson, M.D., Atlanta, Ga.*

CONGENITAL SUBLUXATION OF THE SHOULDER. Leopold Frosch. *Archiv. f. Orthop. u. Unfallschir.*, XXIV, 3, 381, 1926.

Three cases are reported. The patients were between eight and fourteen; two girls and one boy. No complaints were made relative to the shoulders; the children were referred for examination because of general faulty posture. Neither disease nor accident could be cited as etiological factors; it should be especially stated that there was no possibility of previous poliomyelitis, nor was there a history of difficult labor or skeletal anomalies in the family.

The examination revealed that the subluxation was bilateral in all three patients; it was characterized by a marked prominence of the posterior border of the acromion and a change of contour of the shoulder which expressed itself in a greater rounding of the front and a flattening of the back part of the shoulder. The side view of the shoulder differed in its outline of the deltoid muscle, significant for the abnormal position of the head of the humerus. On palpation the latter could be moved backwards about one cm. and upwards about five cm. This motion was accompanied by a noise similar to that encountered in reducing congenital dislocations. The head of the humerus assumed the previous position of forward and downward displacement as soon as the passive support was abolished. There were no findings of muscular anomalies in form or function. Active motion in all directions was not hampered. The x-ray findings disclosed a glenoid cavity which resembled in its haziness of outline those of rickets. The coracoid process was stubby and short. The head of the humerus itself presented no changes from the normal.

The author could find no similar cases reported in previous literature. The treatment was conservative, consisting of massage and manipulations to strengthen the muscles and to prevent further displacement of the head.

The histories of the three cases are included.—*A. Gottlieb, M.D., Los Angeles, Calif.*

LATERAL LUXATION OF THE PATELLA. Michael Freidland. *Archiv. f. Orthop. u. Unfallschir.*, XXIV, 3, 390, 1926.

Referring to his previous article in this publication (Archiv. f. Orthop. u. Unfallschir., XXIII, 3, 1924), the author adds ten cases of this defect to substantiate his theory that the mechanism of production of this deformity is based upon a pathological displacement of the quadriceps muscle laterally. This seems to be the result of a deficiency in the inward rotation of the femur in embryonal life. This observation leads to the conclusion that the radical operation for the old cases of patellar luxation should consist in the mobilization of the patella and in the replacement of the lower third of the rectus muscle mesially, where it should be fixed to the sartorius, adductor magnus and the vastus internus muscles. The other operations, i. e., splitting of the external contracted tissues, capsulorrhaphy of the lengthened tissues on the inner surface of the knee, osteotomy of the genu valgum and others, should be regarded only as accessory methods

to the above muscle replacement. These accessory operative procedures may be indicated when reposition of the patella is otherwise impossible.

The author's operation is as follows: Inwards replacement of the rectus muscle supplemented by capsulorrhaphy and capsulotomy, reposition of the patella, which does not fit into the intercondylar fossa but rests free, supporting itself with its borders upon both condyles. After forcible manipulation of the genu valgum, a supramalleolar osteotomy is performed. The wide open gap in the lateral part of the joint capsule is covered only by the subcutaneous layer of fat and skin. Closure of the skin and application of a plaster-of-Paris cast with a window about the knee joint follow.—*A. Gottlieb, M.D., Los Angeles, Calif.*

LUMBOSACRAL BACKACHE. Charles E. Ayers. *Boston Med. and Surg. J.*, CXCVI, 9, Jan. 6, 1927.

Von Lackum's recent work on the anatomical findings in dissected specimens tends to show that the lumbosacral joint, between a movable spine and a more or less fixed pelvis, is subject to considerable strain and injury.

In the normal spine, the weight-bearing, for the most part, is upon the vertebrae and sacrum. With an increased lordosis in this region, great strain is thrown on the articular facets, with constant steady increase of the deformity. With the strain and activity taking place in this region, arthritis is not an unusual complication. The author cites twenty-two cases in which lumbosacral strain with arthritis was demonstrable, and in which marked destruction of the cartilaginous disc had taken place. These included simple strain, spondylolisthesis, extra lumbar vertebrae with sacralization, and abnormally large spinous processes with impingement.

He believes that aiding nature's attempt to sacralize the fifth lumbar vertebra offers the most satisfactory course of treatment, and to that end, employs the fusion method of Hibbs, giving the following reasons for his choice:

1. That the dissection incident to the exposure of the lumbosacral articulation affords excellent opportunity to examine the posterior portion of the joint; the lateral facets are exposed and one can gain valuable information at this time.
2. The ankylosis, which is secured, extends the whole width of the laminae, even to the lateral facets, giving a very secure bony background for the support of the vertebrae.
3. The minimum risk attendant to the operation when properly performed: in one hundred and one fusion operations there has been no mortality.

Out of nineteen cases operated upon by the author, sixteen are now doing their regular work without pain, the remaining three cases not having progressed far enough to establish the end result.

In conclusion, he states that lateral x-rays of the lumbosacral region are essential in arriving at a diagnosis of low back pain.—*Henry W. Lamb, M.D., Portland, Me.*

THE USE AND ACTION OF O-IODOXY BENZOIC ACID IN THE TREATMENT OF ARTHRITIS. Millard Smith. *Boston Med. and Surg. J.*, CXCVI, 305, Feb. 24, 1927.

Young and Youmans of the University of Michigan have recently reported a series of forty-three cases of arthritis treated by the intravenous injection of o-iodoxy benzoic acid, with marked improvement shown in twenty-four cases, and moderate improvement in ten.

Smith, working at the Thorndike Memorial Laboratory of the Boston City Hospital, reports a series of thirty-three cases with the following results:

In twelve acute cases, eleven obtained marked relief from pain, stiffness and swelling.

Of sixteen chronic cases, all but three showed relief from symptoms.

In two cases of gonorrheal origin; one obtained complete relief, the other, none.

For intravenous therapy the drug is used in the form of sodium or ammonium salt, in a one per cent. aqueous solution at body temperature. The time of injection is from seven to fifteen minutes, 0.5 grams being given for the first dose, and 1.5 grams

for each dose thereafter. If given by mouth, 3 to 4 grams are given daily in 1.0 gram doses, three per cent. solution being used either in capsule or pill form.

The reactions to be expected are: smarting of nose, eyes, mouth and skin; profuse perspiration and sometimes nausea and headache; but these reactions usually last only ten or fifteen minutes.

O-iodoxy benzoic acid has a strong structural similarity to salicylic acid. It is a strong antiseptic and causes a non-specific antibody formation, which, it is believed, aids in combating the infectious element of arthritis.

In general, it is analgesic; relieves muscle spasm and reduces swelling. Even with use of the drug, exhaustive attempts to find and remove the underlying cause of the arthritis should be made, and all possible foci cleared up. The chronicity of joint lesions is no contraindication for trial of this drug.—*Henry W. Lamb, M.D., Portland, Me.*

Experimental Investigations of Function and Regeneration of Muscle Fascia. E. Lucca. *Chir. d. org. di movimento.*, XI, 2, 99, Dec. 1926.

The usefulness of fascia as transplantation material has been known since the first experimental investigations of Kirschner in 1909. The question arises what effect a fascial defect has on the function of the muscle. Serra recently called attention to the importance of the fascia as synergistic factor for muscle action. One must distinguish between muscle fascia and aponeurosis; the latter serving as a field of origin for the muscle fibers, the former being entirely loose and movable; both, however, limit the muscle body. These two types are also embryologically and histologically different. As far as function is concerned, there exists a heated controversy as to the importance of these structures for the muscle mechanism. Cruveilhier and others attribute to it great functional importance; the fascia facilitates the gliding of the fibers, holds the muscle body tight and makes it solid and finally serves as the vehicle for the muscular, nerve and blood supply. Forgue found that after incision into the muscle fascia, when the muscle ends were passively brought together, a hernia occurred. It appears, therefore, that the muscle without its involucrum becomes deformed and that interruption of the fascia would be sufficient to produce a muscle hernia. On the other hand, while the muscle can be squeezed through the rent by an external force, there is never produced a muscle hernia when the muscle contracts under electric stimulation. Pichon maintains that the soft and elastic muscle fibers bulge through the opening in the fascia. Ferrarini, on the other hand, found that the removal of fascial flaps does not lead to herniation of the muscle belly, nor does it change form or contour of the muscle or produce any prominent alteration of the muscle function. Of a muscle hernia, we may speak, according to Ferrarini, only when the contractile element is not sound functionally at least, for instance, in muscle rupture. Another function attributed to the fascia is the constriction of the muscles. Landerer, Klapp, Lorenz, Albert and others affirm this view. On the other hand, Ewald, Lexer and others showed by their investigations that there is no constricting action of the fascial investment. During a contraction the muscle changes its form and the fascia readily adapts itself to the change, but without resistance. Consequently the assertion that a muscle by violent contraction may tear the fascia is without foundation.

From the surgical point of view the most important fasciae are the aponeuroses; first because these are the best material for fascial transplants, second, because muscle hernia (that of the anterior tibial *par exemple*) occurs with preference through the fascia.

With the problem so stated, the author directed his investigations to the fascial aponeuroses, studying first its regenerative ability, biologically, during the stage of activity or inactivity of the muscle, and second, the influence of the fascia, physiologically, upon the function of the muscle. In the first series of experiments the problem of regeneration on the aponeurotic fascia was studied, both under normal muscle function and with elimination of muscle function. To produce the latter situation, he availed himself of the neurectomy of the sciatic nerve, using rabbits for his experiment,

notwithstanding that histological changes are usually associated with the loss of sensory and motor function and that intense hyperemia and oedema follow neurectomy. A square, one cm. in length, was removed from the tibial fascia without injuring the underlying muscle. The nerve was cut from a gluteal incision. The side of the fascial defect was found very soon covered by a layer of connective tissue which was completely substituted for the fascial defect. In no case was there a herniation of the muscle; but when the origin and insertion were passively approached the muscle belly began to bulge through the fascial hole. If the muscle was electrically stimulated, strong contraction on the sound side and weak contraction on the neurectomized side was found, but no muscle hernia occurred, either through the old hole in the fascia or through any rent made during this test.

I. Histological Details.

Differences between sound and paralytic side. After ten days, the defect was covered on both sides by a very vascular granulation tissue and young connective cells. No difference was noted between the two limbs except that there was slightly more oedema on the neurectomized side.

After twenty to thirty days, on the sound side the defect was completely filled by connective tissue, still very rich in young fibroblasts. A fibrous tissue develops from the edges of the hole, melting into the granulation tissue. The fibroblasts arrange themselves in directions parallel to the structure of the fascia.

On the paralyzed side one sees a greater abundance of connective tissue, with oedema, covering the defect. This arises from the perimysium of the underlying muscle. This greater production of fibrous tissue does not show the adequate differentiation and orientation of texture seen on the sound side. There is no trace of densification nor regeneration of the dense fibrous stratum. The loose connective tissue of the aponeurosis, above and below the dense intermediate stratum, is directly continuous with the tissue filling the defect.

After sixty, ninety and one hundred and twenty days, these differences between the normal and the paralyzed side become still more marked. On the sound side, the fascia is completely regenerated. On the paralyzed side, the defect is substituted by an inert mass of cicatricial tissue, dense, exuberant, and adherent to the muscle as well as to the subcutaneous tissue. The edges of the defect show only mere traces of participation in the reparative process. The tissue is very poor in elastic fibers.

II. Physiological Experiments (Guinea Pig).

The assertion of Ferrarini that the fascia has no function in the contraction of the muscles was investigated.

The anterior tibial muscle was exposed. The tendon was severed and attached to the writing point of the kymograph as well as to a weight. The stimulus necessary for greatest contraction and the greatest weight which could be lifted, was determined and the results were tabulated. This gave the values of the greatest absolute muscle power. Then a longitudinal incision was made in the fascia and a piece of it was removed.

The figures showed that in all cases the cut or removal of fascia produced a diminution of the muscle power expressed by the greatest weight that could be lifted, this diminution amounted to sixteen to twenty per cent. They further showed that not only was the absolute muscle power diminished, but also the amount of contracture (in millimeters) under equal weight is diminished in the muscle with fascial defect as compared with the one without. The noticeable decrease of muscle power after the removal of fascia cannot be explained by the loss of a field of insertion of a few muscle fibers since the simple incision of the fascia without removal had the same effect. The author believes that the fascia by its elasticity produces a constant tension of the muscle fibers. Incision or removal of a piece of fascia brings about a change in length of the relaxed muscle and thereby a diminution of its force (a lowering of potential as well as a decrease of its tension). The fascia is, therefore, intimately connected with muscle function, since by reason of its elasticity and also as a point of insertion of muscle fibers, it contributes to the maintenance of constant muscle tone which again insures the best working efficiency of the muscles.—*A. Steindler, M.D., Iowa City, Iowa.*

PRIMARY TUBERCULOSIS OF THE INTRATENDINOUS BURSA OF THE OLECRANON. F. Virgillo. *Chir. d. org. di movimento*, XI, 2, 130, Dec. 1926.

Primary tuberculous lesions of the bursa of the elbow are rare. A case of this kind is described by the author and histological report of it is given.

The following are the bursae about the elbow joint. First, the bursa anconea, a subcutaneous bursa above the olecranon. Second, the bursa subcutanea olecranonic, a subcutaneous bursa between the olecranon and triceps. Third, the bursa subcutanea epicondyli, humeri lateralis, between the skin and lateral condyle of the humerus. Fourth, the subcutaneous bursa of the median epicondyle of the humerus, between skin and median epicondyle. Fifth, the intratendinous bursa of the olecranon, which is situated within the tendon of the triceps. Sixth, subtendinous bursa of the olecranon between the tendon of the triceps and the proximal end of the olecranon.

The case described by the author is one of intratendinous bursa. The absence of other tuberculous lesions classified the case as one of primary bursal lesion, while most of the cases reported as simply para-articular localizations of tuberculosis in other organs. The lesion developed spontaneously and without a preceding trauma. There was, however, an occupational cause, the patient being accustomed to rest his elbow during work.

The treatment consisted in complete removal of the inflamed bursa; aspiration is insufficient. The prognosis is favorable if the lesion is limited to the bursa.—*A. Steindler, M.D., Iowa City, Iowa.*

LATE PARALYTIC SYNDROME IN PATIENTS AFFLICTED WITH SPINA BIFIDA OCCULTA. M. Bufalini. *Chir. d. org. di movimento*, XI, 2, 137, Dec. 1926.

Congenital deformities related to spina bifida occulta according to recent investigations are: Clubfoot, associated with myelocystocele or meningocele, according to observations of Recklinghausen, Bonome, Denucé, etc., or with spina bifida occulta, with or without hypertrichosis.

Another condition often found in spina bifida occulta is incontinence of the bladder. Lumbosacral cleft is found in twelve per cent. of normal individuals but it is seen in forty per cent., and according to some authorities in as much as eighty-four per cent. and sixty per cent., of cases of incontinence. Further symptoms of spina bifida occulta may be sensory, in trophic disturbances, mal perforant, trophoedema, chronic oedema or scleroderma.

Aside from these, however, there are rare observations of localized paralytic manifestations appearing in adult individuals after a long period of latency, which must be brought into relation with spina bifida occulta. In such cases one must assume that a functional equilibrium remains established for a long period of time until in later life it becomes overthrown, giving rise to increasing symptoms of disequilibrium.

The first case reported was that of a young man twenty-two years old who for the last five months has had increasing difficulty in walking, first in one leg and then in the other, until walking became impossible. In addition he complained of coldness and discoloration of the feet. It was found on examination that his lower limbs were strongly adducted and both feet were in equinovarus position. There was rigidity and contracture, greatly increased reflexes, Achilloclonus, Babinski on both sides, also discoloration and hyperaesthesia of segmental distribution. In the dorsolumbar region there existed a tumor the size of an orange, covered with skin, of lipoma-like consistency, which the x-ray revealed to be a spina bifida occulta with dehiscence of the first, second and third lumbar arches. This patient was operated upon, the meninges were found adherent to the wall. A node adherent to the medulla was found and resected. No nerve roots were found in the wall, the tumor was of lipomatous character. After operation the paralysis changed from spasticity to flaccidity.

In a second case, a woman, thirty-two years old, the symptoms dated back ten years. They consisted of difficulty in walking and in sensory and trophic disturbances

similar to the first case. In addition to this there was incontinence. This case also showed a tumor in the upper dorsal region and the x-rays showed a spina bifida occulta from the third to the fifth dorsal vertebrae.

In a third case, a woman, twenty-nine years old; unilateral symptoms began at the age of sixteen,—increasing weakness in limbs, difficulty in moving the toes and pain. Six years later, following puerperal infection, urinary symptoms followed with difficulty of micturition. The left foot was found to be a paralytic equinus with atrophic muscles, there was inability to move the toes, also coldness and discoloration. The knee kicks were normal, there was no Babinski. A tumor was found at the lumbosacral region and the x-ray showed a dehiscence of the fifth lumbar and all of the sacral neural arches.

Acquired and progessive deformities of the foot, such as are shown in these cases were observed by Duncker, Bibergeil and others in shape of pes varus or flat foot deformity. Incontinency in connection with spina bifida occulta was also observed by a number of authors. There are also reports of motor and trophic disturbances. But the series of the author was especially characterized by the paralytic syndrome and he adds five more cases of this kind from the literature. A number of theories were advanced to explain the long latency of symptoms: The incongruent growth of the spine in relation to the medulla; this argument seems to be invalid because of the manifestation of the symptoms later in adult life. The symptoms all seem to come about during a period of hard and heavy manual labor.

Another theory is that of compression by a growing tumor which would tally with the first observation of the author. Syringomyelia, which some authors consider a sequence of spina bifida, ought to be mentioned. Wieting operated on a child five years old and found dilatation of the canal.

The treatment of the condition is surgical and is indicated in cases of mechanical obstacles, such as adhesion or compression. Injection of lipiodol is useful for differentiation. The results recorded in the literature are encouraging; Mutel reports out of forty-six operations, two deaths, four negative results, and of the remaining thirty-eight cases, twenty were cured, nine improved and nine not improved.—*A. Steindler, M.D., Iowa City, Iowa.*

Ossifying Spondylitis. Ralph Stockman. *Edinburgh Med. J.*, XXXIII, 597, Oct. 1926.

Ossifying spondylitis begins as a fibrositis, the result of various different infections. Only exceptionally is this fibrositis confined to the ligaments of the spinal column. Joints and muscles elsewhere have their fibrous tissue involved. It is not yet determined why in a relatively small number of patients bone should be formed in fibrous tissue. It may be recalled that bone is sometimes formed in operation cicatrices, in scar tissue following tuberculous lesions, and in muscles (myositis ossificans) presumably by fibrous tissue cells which have taken on the function of osteoblasts. Ossifying spondylitis is thus only one aspect of a more general question. The new material is usually slowly formed. It consists of spongy bone, rather soft and of wide texture, but here and there are found deposits of amorphous calcareous substance. In a specimen illustrated, the anterior common ligament is completely ossified as are also the costovertebral articulations, and the junction of the first rib with the sternum.

The essential pathology is the formation of new bone in chronically inflamed fibrous tissue, although it is difficult to find any explanation as to why this is more apt to occur in the spine than in peripheral joints. When the anterior common ligament becomes ossified, it simply encases the bodies of the vertebrae where it is in contact with them in a thin layer of new bone. Some or all of the other spinal ligaments are also transformed into bone. When the ossifying process invades the fibrous structures of the joints, the joint cavity becomes obliterated and the articular arrangement is replaced by continuous bone. In many specimens, the bony ridges for attachment of muscles are rough and hypertrophied as along the ribs and the crest of the ilium.

The condition is usually described as osteo-arthritis, but in true osteo-arthritis the

pathology is quite different. In true osteo-arthritis the pathological process is confined to the joints and consists of a peculiar combination of simultaneous bone production and bone absorption resulting in gross deformities of the articular parts of bones. Bony ankylosis never takes place, and the joint cavity is never obliterated, some degree of mobility being always retained.

In some cases of rigid spine, x-ray examination failed to reveal any bony deposit; in these it must be concluded that the rigidity was due to fibrositis and muscular spasm.

(1) Cases after prolonged muscular rheumatism (fibrositis).
Male, 43. Muscular pains and sciatica for twenty years.
Female, 28. Rheumatism and chorea at thirteen years of age.
Female, 25. Rheumatism eighteen years previously. Stiffness of back for three years.

The cause is an infection of low virulence which induces a chronic inflammation of fibrous tissue throughout the body, and at certain places this may take on bone formation.

(2) From gonorrheal rheumatism.
Male, 41. Gonorrhea fifteen years ago. All large joints except wrists are quite rigid.

(3) From dysentery.
Male, 36. Ten years ago dysentery in Gallipoli.

(4) From infective arthritis (rheumatoid arthritis).
Male, 49. Acute onset two years previously in neck, back, shoulders and knees.
Male, 38. Acute onset three years previously in left knee, then right elbow, right knee, right ankle. Temporomandibular joints are stiff.

(5) From chronic lung infection.
Male, 68. For many years chronic purulent bronchitis. Lungs fibrosed, pleura thickened, scoliosis, clubbed fingers.

(6) From injury.
Male, 52. Fourteen years ago fell on head, neck rigid ever since.
Male, 62. Five years ago fell and injured back. For three years lumbar region and legs weak, stiff and painful.

(7) From prolonged immobilization of the spine.
Female, 37. Whole spinal column is perfectly straight and rigid.
At age of fourteen had caries of cervical vertebrae. Had plaster-of-Paris from head to pelvis for five months. Two years and eight months lying flat in bed. Spine immovable ever since.

Ossifying spondylitis is known in horses, oxen, whales and felines, and was common among the ancient Egyptians. The first full account was published in 1877. In 1884 Strumpell referred to two cases. In 1892 Bechterew described the condition at length and attributed it to syphilis, trauma and heredity. In 1898 Marie described it as a special disease under the name of spondylose rhizomélique, i.e., bony ankylosis of the vertebrae and the root joints (hips and shoulders) of the limbs, other joints remaining unaffected. In 1899 Leri attributed it to infection.

Treatment. Once they have formed, the bony deposits cannot be removed nor can the spine be straightened. It is often possible to bring to an end the infection of low virulence which is active in causing and keeping up the generalised fibrositis by protein shock.

The author uses intravenous injection of dead typhoid bacilli; initial dose 50–100 millions, increasing to 150 or 250 millions for each dose. Six intravenous injections should be given at intervals of five or six days.

By perseverance in massage and movements and stretching considerable improvement can be effected. Old standing cases with hard fibrositic deposits never improve much.—*Alexander Gibson, F.R.C.S., Winnipeg.*

ARTHRITIS DEFORMANS. H. C. Adams. *Med. J. Australia*, Dec. 4, 1926.

Arthritis deformans comes under the classification of non-specific infectious arthritis. White race, female sex, an hereditary susceptibility and debility from any cause are predisposing causes. Streptococci, in some focus of infection, are the causative factor in most cases.

Focal infections must be sought for with utmost care. All possible sites must be examined, not once, but repeatedly if necessary, in order to eliminate the cause of arthritis. The commonest causative foci are about teeth. Every devitalized tooth may be suspected. X-ray examination has these limitations: (1) The extent of the absorption does not necessarily express the degree of infection. (2) Areas of infection may be hidden, by a part of the tooth examined, as another root, or by massive bone or an area of condensing osteitis. X-rays also underestimate the size of lesions. The wall of tissue developed by nature around a focal infection as a barrier to absorption varies in resisting power with the individual,—those having the best resistance showing more extensive development of focal lesions before joint symptoms manifest themselves than those with poorer resistance. A high resistance can be lowered by some overload, such as influenza or strain of any kind. In such, a zone of condensing osteitis is usually found, surrounding the zone of absorption. Overlooked foci, may occur from: (1) a small fragment of tooth, left behind after extraction without curetting, (2) a "quiet antrum", (3) areas of absorption missed because of the angle at which the x-ray was taken.—*Edward N. Reed, M.D., Santa Monica, Calif.*

THE TREATMENT OF ARTHRITIS DEFORMANS. By J. W. Hoets. *Med. J. Australia*, Dec. 4, 1926.

Treatment of the general condition should be based upon the idea that infection is the causative factor in most cases. Joints, in general, have low resistance to attack by bacteria or their toxins. The causative focus may not be active at time of examination. The past history is then of help. The elimination of one or more foci may not terminate the arthritis. Search must then be continued for other foci. At times, after the removal of all obviously diseased teeth, the removal of one or more slightly suspicious ones will be followed by spectacular improvement. The presumption is that little or no defence mechanism has been established around these teeth.

Next to teeth come tonsils, in order of suspicion. "In obstinate arthritis there is a definite chance for improvement after tonsillectomy even if the tonsils appear healthy."

The accessory sinuses, the genito-urinary tract and the bowel must all be carefully considered as possible foci.

Arthritis deformans may be a sequel to a general infection, as typhoid fever, influenza, etc., in which case treatment must aim at improvement of the general tone. It may have a metabolic basis, such as a low sugar tolerance or hypothyroidism.

Treatment of the involved joints should be concurrent with treatment of the general condition. The first indication is relief of pain; and this, as well as the prevention of deformity, is met by putting the joints at rest through splints or plaster, in proper position.

In the subacute stage, physiotherapy and active movement are cautiously begun, being more vigorously pushed as pain subsides. In the chronic stage, if improvement is not progressive, the search for lingering foci of infection must be repeatedly made.

Contractures may be stretched out with wedging casts.

Local heat is of great value and is best applied by diathermy.

Phototherapy is very useful and may be applied as heliotherapy or infrared or ultraviolet.

Manipulations under anaesthesia should be undertaken with great caution. They are most useful in recent cases, where periarticular or intra-articular adhesions have not become too dense. Their danger is that the trauma caused may produce more scar tissue and render the situation worse. They should be limited to a single movement through each possible range, to be followed, as soon as possible, by active movements.

Surgical procedures at times needed are tenotomies and tendon lengthenings, arthoplasties and arthodeses. Synovectomy may both restore painless function to a joint and at times remove an active focus of infection.—*E. N. Reed, M.D., Santa Monica, Calif.*

Fracture of the Upper Part of the Shaft of the Humerus Bone. J. W. P. Fransen. *Nederlandsche Maandschrift voor Geneeskunde*, 1926.

The writer wishes to point out the bad functional prognosis of fractures of the upper part of the shaft of the humerus, accompanied by much dislocation. Bloodless replacement immediately after the accident and under narcosis is dangerous and fails in most cases. The success of the classical extension bandage is very doubtful. Various typical bad deformities caused by fractures uniting in wrong positions have been described by Tanton. Owing to the immediate vicinity of the shoulder joint, a small deformity causes very serious limitation to the movements of that joint. Hence, the great importance of the fracture healing in an anatomically correct position. The writer would emphasize the danger threatening the shoulder joint in this form of fracture. Profuse bleeding occurs from the fractured bone surfaces. Loose fragments, described by the French as "ecchymose tardive", is a typical sign of this particular fracture. The scar tissue formed by this large granulating blood clot causes the "peri-arthrite-scapulo-humerale" of Duplag, or the post-traumatic stiff shoulder, which is very obstinate to treat.

In order to prevent this, the profuse bleeding from the fractured bone surfaces must be stopped as soon as possible, and can best be done at the same time as the accurate setting of the fractured bone pieces. Immediate replacement by operation is therefore not only the sovereign means to the acquisition of a perfect restoration of the normal form, but also to the prevention of the periarticular sclerosis. This insures the fracture uniting perfectly from a functional point of view, on condition, of course, that proper after-treatment follows, during which the shoulder joint is not allowed to grow stiff by being given too much rest. The writer operates as soon as possible after the accident, cuts down to the bone (according to Ollier) and replacement is easily effected. Sometimes the long biceps tendon has to be freed. The bones are retained in position by a long pointed drill, the handle of which sticks out of the skin wound. The wound is hermetically closed around the thin drill. The shoulder joint is moved passively every day. The drill is removed after fourteen days and the shoulder joint may then be actively moved.

The writer defends replacement by operation "à chaud".

1. In order to stop the bleeding as soon as possible; an "ecchymose tardive" must not be allowed to take place.

2. For technical reasons, replacement is always easy, callus and scar tissue have not yet formed, the muscles are not yet in a state of contraction.

3. On the "jucunde principle"—after the normal topography has been regained, the reflex muscle cramps disappear immediately.

The author admits that it is true that shortly after the trauma the damaged tissue is very susceptible to infection and hence always insists on an absolute aseptic and antiseptic operative technique.—*Murk Jansen, M.D., Leiden, Holland.*

Diagnostic Inflation of the Knee Joint. Maurice A. Bernstein, and Robert A. Arens. *Radiology*, VII, 500, Dec., 1926.

The value of roentgenograms in diagnosis of knee joint conditions is quite limited, chiefly because of lack of knowledge of x-ray interpretation of soft tissue changes. This is largely because of infrequent checking of x-ray findings against pathology made evident by opening the knee joint.

In the attempt to make visible in a radiogram the outlines of soft structures, liquids and gases have been introduced into the joint; gases are preferable, because of the greater

irritation and slower absorption of liquids. The authors used carbon dioxide, because of ready absorption and slight irritation.

The knee joint contains synovial lined cavities as follows: a small posterior and a large anterior compartment; also an extension for about an inch and a half above the patella,—the suprapatellar pouch. Stretching across the infrapatellar space can be seen the triangular fold or fat pad, supported at two sides by the alar ligaments and in the center by the ligamentium mucosum.

Soft tissue lesions which need to be diagnosed are: (1) Tears of the ligaments; (2) Displacements and tears of the cartilages; and (3) Chronic synovitis.

Technique: Under careful aseptic precautions, the tissues at the inner and lower border of the patella are infiltrated with one-half per cent. novocaine and a good sized needle introduced into the joint. The carbon dioxide is allowed to pass through the tube before connection with the needle, in order to clear it of air. The gas is allowed to enter the joint slowly. Should the patient show signs of syncope, the needle is withdrawn at once. To avoid trauma of the joint, the needle should not be handled unnecessarily, after introduction.

A radiogram is taken before introducing the needle: 75 c.c. of gas are allowed to flow in, enough to produce a soft crepitus over the entire knee and distention of the joint. This produces some pain, which is of short duration. The needle is quickly withdrawn.

A second radiogram is then taken in the same position as the first. In a normal knee, the joint area above the patella shows a gall-bladder-shaped shadow corresponding to the suprapatellar pouch. The area behind and below the patella, between the articular surfaces of the tibia and femur, is clear and slit-like. The shadow of the posterior compartment is clear and elliptical. Infiltration of the soft tissues causes diminished size and irregular outline in the shadows of these spaces. Bands may be seen crossing them. The spaces may be obliterated. Tuberculosis may increase their size. Cartilaginous bodies may appear. The authors have had no untoward results from the procedure. The gas is usually absorbed in from one to two days.—*E. N. Reed, M.D., Santa Monica, Calif.*

FIVE CASES OF PES CAVUS WITH METATARSUS VARUS TREATED BY TARSAL CUNEIFORM OSTEOTOMY. Ath. Contargyris. *Rev. d'Orthop.*, 343, July 1926.

In these cases the deformity was due to the paralysis of the external popliteal nerve injured by a traumatism. The steps of the operation are: (1) Make a middle linear incision over the dorsum starting at Lisfranc's joint and running down about four inches. (2) Remove the periosteum as far as the first and fifth metatarsals. (3) Chisel out a wedge from the heads of metatarsals and cuneiform bones. (This wedge ought to be extended toward the external side in order to obtain complete correction.) (4) Apply plaster-of-Paris for eight weeks.

The result has been very satisfactory, the deformity appears nicely corrected, and there is not a visible shortening of foot, because according to the Delpech's law, the deformed bones enlarge their dorsal aspect, which is free of pressure, while the plantar side does not change.—*Felipe Muro, M.D., Detroit, Mich.*